Health Risk Assessments for Proposed Land Use Projects

CAPCOA Guidance Document

CAPCOA
CALIFORNIA AIR POLLUTION CONTROL OFFICERS ASSOCIATION

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Glossary

Acute Hazard Index	Acute Hazard Index is the ratio of the average short term (generally one hour) ambient concentration of an acutely toxic substance(s) divided by the acute reference exposure level set by the Office of Environmental Health Hazard Assessment. If this ratio is above one, then adverse health effects may occur.
Background Risk	Background risk is the risk level found throughout an area. This risk is not caused by a particular facility; it is the cumulative risk and may be partly due to air pollution from vehicle traffic.
Cancer Risk	Cancer risk is defined as the probability that an individual will contract cancer usually expressed as so many chances per million persons exposed to a specified concentration of carcinogenic substance(s).
Chronic Hazard Index	Chronic Hazard Index is the ratio of the average annual ambient concentration of a chronically toxic substance(s) divided by the chronic reference exposure level set by the Office of Environmental Health Hazard Assessment. If this ratio is above one, then adverse health effects may occur.
Commenting Agency	A commenting agency is any public agency that comments on a CEQA document, but is neither a lead agency nor a responsible agency. For example, a local air district, as the agency with the responsibility for air pollution control, could review and comment on an air quality analysis in a CEQA document, even though the project was not subject to an air permit or other air pollution control requirements.
Cumulative impact	Cumulative impacts represent the risks from all onsite sources and from sources near enough to the project to significantly contribute to the total risk levels.
Hot Spots Program	Health and Safety Code §44300-44394, Program which requires existing sources to inventory toxic emissions, prepare risk assessments, notify significantly exposed receptors, and prepare and implement risk reduction plans.
Lead Agency	A lead agency is the public agency that has the principal responsibility for carrying out or approving a project that is subject to CEQA. In general, the land use agency is the preferred public agency serving as lead agency, because it has jurisdiction over general land uses. The lead agency is responsible for determining the appropriate environmental document, as well as its preparation.

Receptors	Receptors include sensitive receptors and worker receptors. Sensitive receptors refer to those segments of the population most susceptible to poor air quality (i.e., children, the elderly, and those with pre-existing serious health problems affected by air quality). Land uses where sensitive individuals are most likely to spend time include schools and schoolyards, parks and playgrounds, daycare centers, nursing homes, hospitals, and residential communities (these sensitive land uses may also be referred to as sensitive receptors). Worker receptors refer to employees and locations where people work.
Responsible Agency	A responsible agency is a public agency, other than the lead agency, with discretionary approval authority over a project that is subject to CEQA (i.e., project requires a subsequent permit).
Risk Assessment	An evaluation that assesses the impact of toxic substances affecting receptors. A risk assessment can include minimal input parameters resulting in conservative results (screening risk assessment) or include increasingly detailed input parameters (refined risk assessment).
Source	A source is referred to as the locality where toxic emissions originate and are released into the atmosphere. Sources of emissions are categorized into groups such as point source (e.g., refinery) or line source (e.g., roadway).
Type A Project	Land use project that impacts receptors near the project.
Type B Project	Land use project with receptors that are impacted by nearby, existing toxics sources.

Acronyms

ARB:	California Air Resources Board
ATCM:	Air Toxic Control Measure
CAPCOA:	California Air Pollution Control Officers Association
CEQA:	California Environmental Quality Act
DPM:	Diesel Particulate Matter
EIR:	Environmental Impact Report
EPA:	U.S. Environmental Protection Agency
HRA:	Health Risk Assessment
OEHHA:	California Office of Environmental Health Hazard Assessment
PM:	Particulate Matter
REL:	Reference Exposure Level
TAC:	Toxic Air Contaminant
TBACT:	Toxic Best Available Control Technology

Executive Summary

This guidance was prepared to assist Lead Agencies in complying with the requirements of the California Environmental Quality Act (CEQA)[1]. CEQA requires environmental impacts of a proposed project be identified, assessed, and avoided or mitigated (as possible) if these impacts are significant. To determine the impact of airborne toxic emissions [i.e., toxic air contaminants (TACs)] for CEQA purposes, health risk assessments must be prepared. This document describes when and how a health risk assessment should be prepared and what to do with the results.

In 2005, the California Air Resources Board (ARB) prepared the ***Air Quality and Land Use Handbook: a Community Health Perspective*** **(ARB Handbook)**[2], to help readers understand the potential cancer risks from some common sources of toxic emissions such as:

- Freeways and High Traffic Volume Roads,
- Goods Distribution Centers,
- Rail Yards,
- Ports,
- Refineries,
- Chrome Platers,
- Dry Cleaners using Perchloroethylene, and
- Gasoline Dispensing Facilities.

The ARB Handbook identified the potential cancer risks at various distances from these sources and recommended buffer distances between those sources and receptors.

Recent air pollution studies have shown an association between respiratory and other non-cancer health effects and proximity to high traffic roadways. Other studies have shown that diesel exhaust and other cancer-causing chemicals emitted from cars and trucks are responsible for much of the overall cancer risk from airborne toxics in California.

While local air districts have ample experience evaluating and mitigating toxic emissions from permitted stationary sources, most have limited experience preparing or reviewing risk assessments associated with multiple toxic sources or assessments for exhaust from mobile sources that are typically found when evaluating health risks to proposed land use projects.

In order to provide consistency to lead agencies, project proponents and the general public throughout the state, the California Air Pollution Control Officers Association (CAPCOA) formed a subcommittee composed of representatives from the Planning Managers Committee and the Toxic Risk Managers Committee to develop guidance on assessing the health risk impacts from and to proposed land use projects. This CAPCOA guidance document focuses on the acute, chronic, and cancer impacts of sources affected by CEQA. It also outlines the

[1] Title 14 California Code of Regulations, Chapter 3. Guidelines for Implementation of the California Environmental Quality Act.

[2] Air Quality and Land Use Handbook: a Community Health Perspective, CARB, April 2005, http://www.arb.ca.gov/ch/handbook.pdf

recommended procedures to identify when a project should undergo further risk evaluation, how to conduct the health risk assessment (HRA), how to engage the public, what to do with the results from the HRA, and what mitigation measures may be appropriate for various land use projects. With respect to health risks associated with locating sensitive land uses in proximity to freeways and other high traffic roadways, HRA modeling may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

This guidance does not include how risk assessments for construction projects should be addressed in CEQA. As this is intended to be a "living document", the risks near construction projects are expected to be included at a later time as the toxic emissions from construction activities are better quantified. State risk assessment policy is likely to change to reflect current science, and therefore this document will need modification as this occurs.

1.0 Requirements to Evaluate Health Risks in CEQA

This guidance was prepared to assist Lead Agencies in complying with the requirements of the California Environmental Quality Act (CEQA)[3]. CEQA requires that environmental impacts of proposed projects be identified, assessed, avoided and/or mitigated (as possible) if the environmental impacts are significant.

Section 15126.2(a) requires the following: *"An Environmental Impact Report (EIR) shall identify and focus on the significant environmental effects of the proposed project. In assessing the impact of a proposed project on the environment, the lead agency should normally limit its examination to changes in the existing physical conditions in the affected area as they exist at the time the notice of preparation is published, or where no notice of preparation is published, at the time environmental analysis is commenced. Direct and indirect significant effects of the project on the environment shall be clearly identified and described, giving due consideration to both the short-term and long-term effects. The discussion should include relevant specifics of the area, the resources involved, physical changes, alterations to ecological systems, and changes induced in population distribution, population concentration, the human use of the land (including commercial and residential development), health and safety problems caused by the physical changes, and other aspects of the resource base such as water, historical resources, scenic quality, and public services. The EIR shall also analyze any significant environmental effects the project might cause by bringing development and people into the area affected. For example, an EIR on a subdivision astride an active fault line should identify as a significant effect the seismic hazard to future occupants of the subdivision. The subdivision would have the effect of attracting people to the location and exposing them to the hazards found there."*

This language is included here to clearly show that risk assessments can be required for both projects that will impact nearby receptors (Type A), and projects that will be impacted by nearby sources (Type B).

[3] Pub. Resources Code § 21067; 14 Cal. Code Regs., §§ 15150, 15367.

2.0 Overview of the Process

Figure 1 shows an overview of the proposed Health risk Assessment (HRA) process. There are basically two types of land use projects that have the potential to cause long-term public health risk impacts:

Type A - Land use projects with toxic emissions that impact receptors, and
Type B - Land use project that will place receptors in the vicinity of existing toxics sources.

Type A project examples (project impacts receptors):
- combustion related power plants,
- gasoline dispensing facilities,
- asphalt batch plants,
- warehouse distribution centers,
- quarry operations, and
- other stationary sources that emit toxic substances.

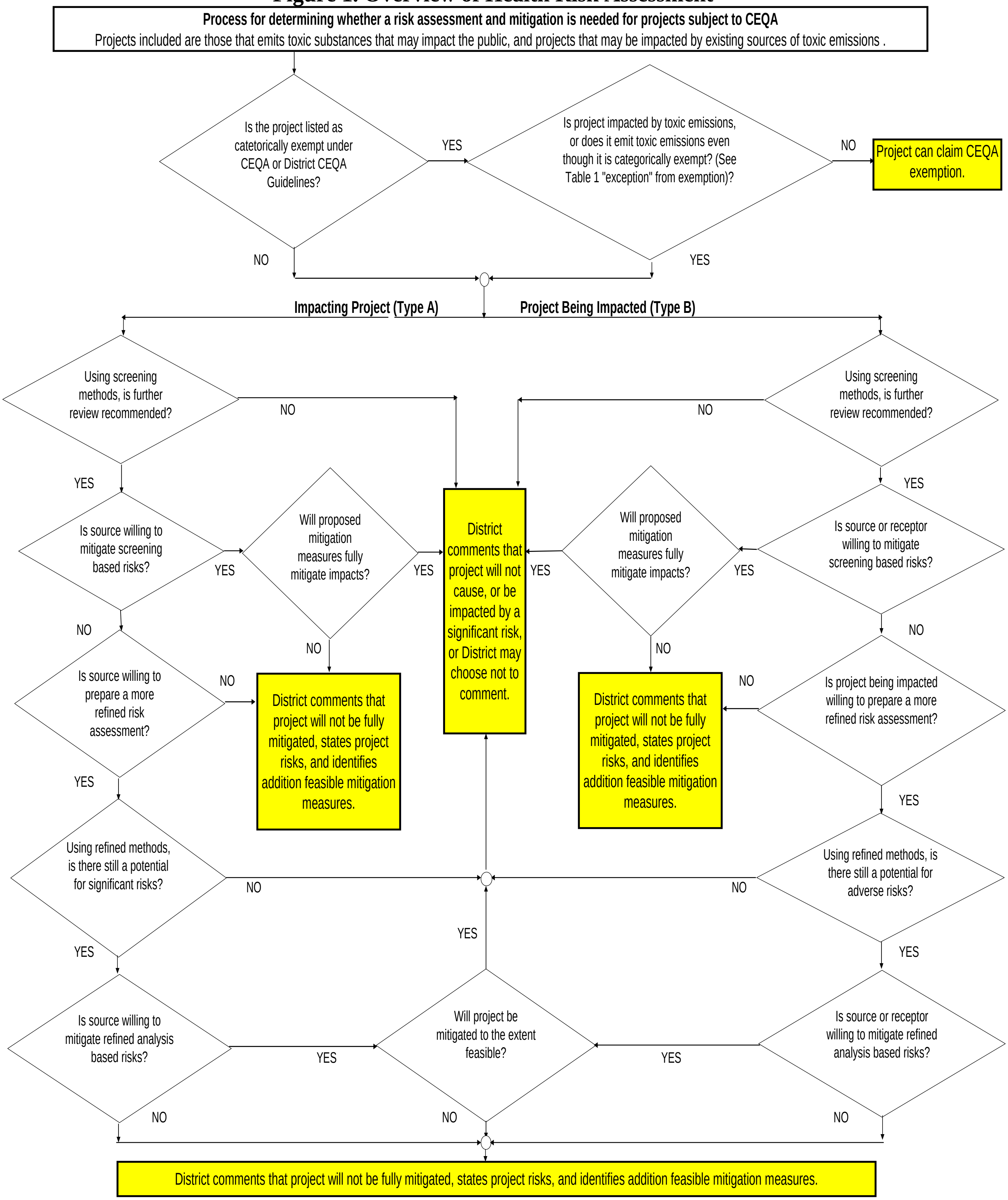
Type B project examples (project impacted by existing nearby toxic sources):
- residential, commercial, and institutional developments proposed to be located in the vicinity of existing toxic emission sources such as:
  - stationary sources,
  - high traffic roads
  - freeways,
  - rail yards, and
  - ports.

The flowchart (Figure 1) shows how to proceed with the CEQA process when either a Type A or Type B related project is proposed. The following summarizes the process for proceeding through the flowchart:

- First determine if the project is categorically exempt from CEQA;
- Next, determine if the project is impacting, or being impacted (Type A or B);
- Using screening methods, calculate acute, chronic, and cancer risk;
- If the screening analysis indicates significant health risk as defined by the lead agency, demonstrate that risks will be mitigated with all feasible measures even though a refined risk assessment may show that less mitigation is needed;
- Or, conduct a refined screening risk assessment; and,
- If the risk continues to be deemed significant by the lead agency even with the refined screening, demonstrate that the risks will be adequately mitigated with feasible measures.

Air districts, in their role as either a responsible agency or a commenting agency, should review the HRA and communicate to the lead agency their evaluation of the risk assessment and whether it is fully described (e.g., methodology, assumptions and resulting risk values) and mitigated with all feasible measures.

Figure 1. Overview of Health Risk Assessment



3.0 Overview of Risk Assessment Methodology and Guidance Documents

This document bases the risk assessment methodology on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA) to meet the mandates of the Air Toxics "Hot Spots" Information and Assessment Act (AB 2588). The Hot Spots program applies to stationary sources and requires affected facilities to prepare a toxic emissions inventory, and if the emissions are significant, that a risk assessment be prepared. The OEHHA procedures can be found at http://www.oehha.ca.gov/air/hot_spots/index.html and describe:

- The toxicity factors associated with various substances,
- How these toxicity factor are to be used to determine the acute, chronic, and cancer risks associated with downwind concentrations of chemicals in the air at various receptors, and
- Dispersion modeling procedures.

4.0 CEQA Exemptions

The first step in a risk analysis is to determine if the project is statutorily or categorically exempt from CEQA. There are no exceptions to statutorily exempt projects, however, certain projects that are categorically exempt under the state or air district guidelines, may emit toxic emissions or may be impacted by existing toxic sources. Table 1 shows the exceptions from categorical exemptions where an HRA evaluation is needed. These are situations where a project proponent or lead agency may not rely on a categorical exemption because the health risk may trigger an exception (CEQA §15300.2), preventing their use. In such cases, a negative declaration or environmental impact report should be prepared.

Table 1
Categorical Exemptions Requiring HRA Evaluation[4]

Categorical Exemption	**Exempt Activity with *Possible Impact***
15301. Existing Facilities	This exemption also allows use of a single-family residence as a day care facility without CEQA review. *However, such uses near existing TAC emissions may warrant further review.*
15302. Replacement or Reconstruction	This exemption allows the replacement or construction of existing schools and hospitals in certain cases without CEQA review. *However, locating new facilities near existing TAC emissions may warrant further review.*
15303. New Construction or Conversion of Small Structures	This exemption class allows small new construction projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources.*
15314. Minor Additions to Schools	This exemption class allows small school addition projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources.*
15316. Transfer of Ownership of Land in Order to Create Parks	Exemptions in this class should be reviewed for *possible impacts from locating near ongoing sources of TAC.*
15332. In-Fill Development Projects.	This exemption class allows certain in-fill development projects to proceed without CEQA review. *However, projects claiming this exemption should be reviewed for possible TAC impacts from ongoing nearby sources such as high volume roadways and freeways.*

[4] Although methodology for assessing health risk for construction projects is not included in this document, lead agencies under CEQA are required to identify health risk from construction activities or projects and mitigate if they are deemed significant.

5.0 Screening Risk Assessments

Various tools already exist to perform a screening analysis from stationary sources impacting receptors (Type A projects) as developed for the AB2588 Hot Spots and air district permitting programs. Local air districts should be contacted for appropriate screening tools for proposed projects. Screening tools may include: prioritization charts, SCREEN3 and various spreadsheets.

For projects being impacted by existing sources (Type B projects), one screening tool is contained in the ARB Handbook[4]. The handbook includes a table (reproduced in these guidance documents as Table 2) with recommended buffer distances associated with various types of common sources. ARB's Handbook focuses on community health and provides important public health information to land use decision makers. In this document, ARB's primary goal is to provide information that will help keep California's children and other vulnerable populations out of harm's way with respect to nearby sources of air pollution.

For example, as shown in Table 2, ARB recommends avoiding siting new sensitive land uses such as residences, schools, daycare centers, playgrounds, or medical facilities within 500 feet of a freeway, urban roads with traffic volumes exceeding 100,000 vehicles/day, or rural roads with volumes greater than 50,000 vehicles/ day. Therefore, siting a residential project within 500 feet of a freeway, and the associated public health risks, should be disclosed as such in a CEQA document. Re-designing the project so that sensitive receptors are moved greater than 500 feet away from such roadways may mitigate the risk. Other non-sensitive land uses such as commercial uses may be sited in this area. ARB recommends that their guidelines be considered by the decision makers along with housing needs, economic development priorities, and other quality of life issues. It should also be noted that health risk assessments conducted on sensitive land uses in close proximity to freeways and other high traffic roadways may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

Table 2
Recommendations on Siting New Sensitive Land Uses Such As Residences, Schools, Daycare Centers, Playgrounds, or Medical Facilities [5]

Source Category	Advisory Recommendations
Freeways and high-traffic roads	• Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles per day.
Distribution centers	• Avoid siting new sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating transport refrigeration units (TRUs) per day, or where TRU unit operations exceed 300 hours per week). • Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit points.
Rail yards	• Avoid siting new sensitive land uses within 1,000 feet of a major service and maintenance rail yard. • Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	• Avoid siting of new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult local air districts or the ARB on the status of pending analyses of health risks.
Refineries	• Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.
Chrome platers	• Avoid siting new sensitive land uses within 1,000 feet of a chrome plater.
Dry cleaners using perchloroethylene	• Avoid siting new sensitive land uses within 300 feet of any dry cleaning operation. For operations with two or more machines, provide 500 feet. For operations with 3 or more machines, consult with the local air district. • Do not site new sensitive land uses in the same building with perc dry cleaning operations.
Gasoline dispensing facilities	• Avoid siting new sensitive land uses within 300 feet of a large gas station (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50 foot separation is recommended for typical gas dispensing facilities.

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- These recommendations are advisory. Land use agencies have to balance other considerations, including housing and transportation needs, economic development priorities, and other quality of life issues.
- Recommendations are based primarily on data showing that the air pollution exposures addressed here (i.e., localized) can be reduced as much as 80% with the recommended separation.
- The relative risk for these categories varies greatly. To determine the actual risk near a particular facility, a site-specific analysis would be required. Risk from diesel PM will decrease over time as cleaner technology phases in.
- These recommendations are designed to fill a gap where information about existing facilities may not be readily available and are not designed to substitute for more specific information if it exists. The recommended distances take into account other factors in addition to available health risk data (see individual category descriptions).
- Site-specific project design improvements may help reduce air pollution exposures and should also be considered when siting new sensitive land uses.
- This table does not imply that mixed residential and commercial development in general is incompatible. Rather it focuses on known problems like dry cleaners using Perchloroethylene that can be addressed with reasonable preventative actions.
- A summary of the basis for the distance recommendations can be found in the ARB Handbook.

6.0 Refined Risk Assessments

If a screening risk assessment shows that a risk is a concern, then a more refined analysis may be prepared. The refined analysis for the project may show lower risks, and provide more accurate information for decision makers. The screening assessment uses more conservative assumptions and thus gives higher risk than refined assessment. Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. These guidelines include the evaluation of both mobile and stationary sources.

Attachment 1 to this document consists of the ***Technical Modeling and Risk Assessment Guidance*** which address various air quality dispersion modeling issues pertinent to California and is based primarily on information found in ARB, EPA and OEHHA guidance.

Appendix A, ***Meteorological Data,*** provides information on preparing meteorological data, mixing height and upper air data and land use characterization.

Appendix B, ***Modeling and Exposure Assessment Input and Output Data,*** is a checklist of parameters designed to provide an overview of all information that should be submitted for a refined air dispersion modeling assessment.

7.0 Risk Thresholds

An air district can set CEQA significant risk thresholds (e.g. the excess cancer risk shall be less than ten per million, the acute or chronic hazard index shall be less than one, or other significance levels as arrived at through a public process) that are used on a per-project basis. If the air district's governing board has adopted specific risk thresholds, the lead agency may choose to use them to determine acceptable risk levels. Additionally, clear risk thresholds are helpful when mitigation measures are necessary. The degree of mitigation can be clearly defined when a risk threshold has been determined before a project is proposed.

The absence of a risk threshold does not relieve an agency of its obligation to address toxic emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting as a commenting agency, as a responsible agency, or as a lead agency.

7.1 Significant Risk Thresholds - Type A (Impacting Sources)

For Type A projects, those that generate toxic air contaminants (such as gasoline stations, distribution facilities or asphalt batch plants), air districts are uniform in their recommendation to use the significance thresholds that have been established under each district's "Hot Spots" and permitting programs. For the majority of the air districts the **excess cancer risk** significance threshold is set at **10 in a million**. For toxic air contaminants with acute and chronic, non-carcinogenic health effect, a **hazard index of one** must not be exceeded. Depending on the substances being emitted, a project with a hazard index greater than one could result in adverse health effects of various sorts. It should be noted that a hazard index exceeding one may need additional analysis to determine whether the acceptable level of acute or chronic risk could be higher depending upon the safety factors that were incorporated into the reference exposure levels (RELs) associated with the hazard index results. This additional analysis could be considered an additional refinement tier.

It should be noted that these thresholds may be applied differently for air district permitting, the Hot Spots program, and CEQA. For air district permitting, the thresholds apply only to individual permit units. For the Hot Spots program, the thresholds apply to the entire facility excluding vehicle emissions. Neither the permitting programs nor the Hot Spots program apply to vehicle emissions. For CEQA, the thresholds apply to <u>all</u> facilities including vehicle emissions, and road related emissions.

7.2 Significant Risk Thresholds - Type B (Projects Impacted by Existing Sources)

For Type B projects, those that are impacted by existing sources, air districts are not uniform in their recommendation on what significance threshold should be adopted or what processes should be undertaken when disclosing potential risks.

The CEQA statutes encourage an air district or any lead agency to establish significance thresholds under CEQA for any pollutant. While there are considerations that support the establishment of thresholds, there is no obligation to do so. The absence of a threshold does not relieve agencies of their obligations to address toxic emissions from projects under CEQA. The implications of not having a threshold are different depending on the role the agency has under CEQA – whether it is acting in commenting agency, as a responsible agency, or as a lead agency.

An air district or other lead agency may elect not to establish significance thresholds for a number of reasons.

A lead agency or air district may also determine there is insufficient information to support selecting one specific threshold over another. Air districts have historically recommended CEQA thresholds for air pollutants in the context of the air district's clean air attainment plan, or (in the case of toxic air pollutants) within the framework of a rule or policy that manages risks and exposures due to toxic pollutants.

Significance levels have been approached differently by air districts as enumerated below:

- Thresholds can be based on a specific risk level such that a 10 per million excess cancer risk and an acute and chronic hazard index of one should not be exceeded. These thresholds tend to be consistent with the Hot Spot Program thresholds.
- Thresholds can also be based on the region's existing background cancer risk value if one exists.
    - One option is to establish a risk level equal to a region's background risk level.
    - Another option is to establish a risk level equal to twice a region's background risk level.
    - Still another option is to look at the ambient risk in the immediate vicinity of the project area rather than the regional risk level.
- Case by case thresholds may also be defined.

8.0 Mitigation Measures

CEQA requires that adverse environmental impacts of a proposed project be identified, assessed, avoided, and, if deemed significant, mitigated (as feasible) to a level that is considered less than significant. "'Feasible' means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, legal, social, and technological factors" (CEQA Guidelines §15364).

In cases where significant adverse impacts are not avoided or substantially lessened, the public agency may approve the project if it first adopts a "statement of overriding considerations." The statement of overriding considerations sets forth the specific reasons why the public agency found the project's benefits outweigh its unavoidable adverse environmental effects (CEQA Guidelines§15043).

In addition to being a CEQA requirement, mitigating public exposure to toxic air pollution is needed to achieve air district goals. All potentially significant emission sources must be mitigated to the greatest extent feasible, including placing people out of harm's way.

Table 3 presents mitigation measures that are currently considered to be feasible to reduce health risk from both Type A and Type B projects. The mitigation measures included in the table are not considered to be exhaustive. The lead agency and project proponents are encouraged to think creatively in devising measures to mitigate air quality impacts. However, the air districts recognize that the final determination of feasibility for a project will be determined by the lead agency. Aside from the mitigation measures shown below, knowing about the regulatory programs to reduce air pollutant emissions through statewide strategies provide information to local air districts and lead agencies to help assess and mitigate cumulative air pollution impacts as well.

8.1 Mitigations due to Air Toxic Control Measures

ARB has been developing Air Toxic Control Measures (ATCMs) for many years. Many of these measures have a phase-in schedule. Implementation of others has already been completed. While cancer and non-cancer risks from the air toxic sources implementing ATCMs are expected to decrease with time, the Office of Environmental Health Hazard Assessment (OEHHA) recommends that it is inappropriate to assume these yet-to-be realized emissions reductions in a health-risk assessment. However, the project proponent is encouraged to become familiar with existing and proposed ATCMs in order to determine if any of the ATCMs affect project-specific emissions.

8.2 Mitigating Through Land Use and Design

To a certain extent, the long-term air quality impact of a project is a function of its design. The layout of streets, the mix of land uses, and the placement of homes and businesses can all affect overall project emissions. Yet in many instances, the air quality impacts of a project are not considered until well after a project has been designed. At such a late stage, it can be very difficult to make any substantial changes to the project to reduce the project's air quality impact.

As indicated throughout the ARB Handbook, land use agencies are strongly encouraged to consult early and often with local air districts. Including air quality considerations during the initial design phase can help an applicant to implement design features that will reduce its air quality impact.

In addition to considering the suitability of the project location, opportunities for mitigation of air pollution impacts through design should be considered. In some cases, control devices and changes in processes may be implemented at the source in order to reduce the risk from toxic air contaminant emissions. Examples of land-use based air quality specific performance standards include the following:

- Placing a process vent away from the direction of nearby receptors, or increasing the stack height so that emissions are dispersed to reduce the emissions impact on the immediate surroundings.
- Limiting the hours of operation of a facility to avoid excess emissions exposure to nearby individuals.
- An ordinance that requires fleet operators to use cleaner vehicles before project approval (if a new business), or when expanding the fleet (if an existing business).
- Providing alternate routes for truck operations that discourage detours into sensitive receptor neighborhoods.

While such measures may reduce the dimensions of a buffer zone, they do not obviate the need to maintain buffer zones to protect public health and safety. This is particularly true in situations where a sensitive receptor is encroaching on an existing source of toxic air contaminant. Also note disclosure statements, community alert procedures, etc., that are targeted at potential receptors are not appropriate mitigations to be used in lieu of buffer zones or technical controls.

Table 3 below contains examples of both project and program-level mitigation measures.

- <u>Project-level</u> mitigation measures are applicable to development which results in the implementation or modification of a land use which creates unacceptable levels of risk. Examples include redesigning the project to locate receptors away from TAC sources, the installation of barriers and/or vegetation and indoor air filtration.

- <u>Program-level</u> mitigation measures, on the other hand, are applicable to long-range community planning such as General Plans, and address land use incompatibility at a much earlier stage. Examples of program-level mitigation measures include rezoning vacant land adjacent to high-volume roadways, ports, railroads or heavy industry to avoid future proposed siting of residential and/or sensitive receptors.

8.3 Mitigation Effectiveness

The mitigation measures identified in Table 3 include both quantifiable and unquantifiable measures.

8.3.1 Quantifiable Mitigation Measures

The effect of quantifiable mitigation measures can be modeled or calculated beyond a reasonable doubt. As pertaining to health risk impacts, quantifiable mitigation measures generally result in a measurable reduction of toxic air contaminant emissions (such as DPM), or a measurable decrease in exposure to such emissions through increased buffer distances, reduced exposure durations or control devices having a certified control effectiveness.

Examples of quantifiable mitigation measures include:

- Diesel particulate filters: as of 2008, DPFs reduce the emissions of diesel particulate matter up to 85% as verified by the CARB.
- Increasing the distance between a TAC source and receptor may reduce the receptor's level of exposure to TACs; the effect of this mitigation measure can be estimated through dispersion modeling;
- Idling restrictions can greatly reduce or completely eliminate DPM emissions from stationary trucks; if such restrictions are quantitative and include a concrete limit on the number of minutes a truck (or similar) is allowed to idle, the benefits of this mitigation measure can be modeled.

Several cautionary notes regarding estimating the effectiveness of mitigation measures are warranted:

- Clearly explain the assumptions underlying the environmental document's analysis of mitigation measure effectiveness. The analysis should specifically describe the mitigation measure, identify the source(s) of air pollutants that are expected to be affected by the measure, clearly explain how and to what extent the measure will affect the source(s), and identify the basis for the estimate (empirical observations, computer modeling, case studies, etc.). Critical assumptions should be linked to the mitigation monitoring and reporting program.

- Be specific regarding implementation of mitigation measures. The environmental document should describe each mitigation measure in detail, identify who is responsible for implementing the measure, and clearly explain how and when the measure will be implemented. Methods for assessing the measure's effectiveness once it is in place, and possible triggers for additional mitigation if necessary, may be needed. This level of detail regarding mitigation measure implementation frequently is not addressed until the preparation of the mitigation monitoring and reporting program, which often takes place very late in the environmental review process. In order to reliably assess the effectiveness and feasibility of mitigation measures, however, air agencies believe it is necessary to consider the specifics of mitigation measure implementation as early in the environmental review process as possible.

- Be sure not to double count the effect of proposed mitigation measures. The project description and assumptions underlying the analysis of project impacts should be carefully considered when estimating the effect of mitigation measures. If certain conditions or behavior are assumed in the impact analysis, then credit may not be claimed when proposing mitigation measures.

- Health risk assessments discussed in this document estimate outdoor risk. While some mitigation measures may reduce risks by filtering outdoor air to be used indoors, they do nothing to reduce the risk assessment values for outdoor air.

8.3.2 Unquantifiable Mitigation Measures

In some cases, it simply may not be possible to quantify the effect of proposed mitigation measures. It may be that the specific conditions surrounding a particular project are so unique as to render extrapolation from other examples unreliable. A proposed measure may be innovative, with little precedent. The combined effects of a package of measures may be too difficult to quantify. While a certain degree of professional judgment is usually involved in estimating the effectiveness of mitigation measures, speculative estimates should be avoided. If the project proponent cannot quantify mitigation effectiveness with a reasonable degree of certainty, the environmental document should at least address effectiveness qualitatively. If the lead-agency makes a finding that non-quantified mitigation measures reduce an impact to a level of insignificance, the document should provide a detailed justification of that conclusion.

8.3.2.1 Effects of Vegetation Next to Roadways

The Sacramento Air District funded a study to measure the removal rates of particulate matter passing through leaves and needles of vegetation. Particles were generated in a wind tunnel and a static chamber and passed through vegetative layers at low wind velocities. Redwood, deodar cedar, live oak, and oleander were tested. The results from this study indicate that all forms of vegetation able to remove 65-85 percent of very fine particles at wind velocities below 1.5 meters per second (roughly 3 miles per hour) with redwood and deodar cedar being the most effective.

This study supports the effectiveness of planting finely needled trees along sources of toxic particulate matter as an air toxics mitigation measure. Though further studies that reflect actual roadway conditions are needed to better quantify the real-world effectiveness of this mitigation measure, projects that propose sensitive receptors adjacent to sources of particulate matter such as freeways, major roadways, rail lines, and rail yards should consider tiered plantings of redwood and/or deodar cedar in order to reduce toxic exposures.

8.3.2.2 No Idle Zone

California law currently places restrictions on idling of heavy-duty diesel motor vehicles to reduce health risk impacts from diesel emissions. The 2003 school bus idling airborne toxic control measure (ATCM) requires a driver of a school bus or vehicle, transit bus, or other commercial motor vehicle to manually turn off the bus or vehicle engine upon arriving at a school and to restart no more than 30 seconds before departing. A driver of a school bus or vehicle is subject to the same requirement when operating within 100 feet of a school and is prohibited from idling more than five minutes at each stop beyond schools, such as parking or maintenance facilities, school bus stops, or school activity destinations.

California's more recent anti-idling regulations (with some exemptions) require that drivers of diesel-fueled commercial vehicles weighing more than 10,000 pounds:

- Shall not idle the vehicle's primary diesel engine for greater than 5 minutes at any location,
- Shall not use diesel-fueled auxiliary power units for more than 5 minutes to power a heater, air conditioner, or any ancillary equipment on the vehicle equipped with a sleeper berth, at any location.

Lead agencies may place additional requirements on heavy duty diesel delivery and haul trucks less than 10,000 pounds, and create "no idle" zones at locations where there is a potential for significant health risk. It may not be possible to quantify the emission reductions associated with the creation of a no idling zone. However, this feasible mitigation measure may eliminate idling emissions and may avoid potentially significant health risk impacts.

Table 3
Mitigation Measures

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Stationary Sources Type A (Sources Impacting receptors) (e.g., Auto body shops, Gas Stations, Manufacturers, Metal Platers, Chemical Producers, Rock Quarries, Incinerators, Power Plants, Diesel Engines)	1. Move source location to provide effective buffer zone. 2. Reduce throughput. 3. Install Toxic Best Available Control Technology (TBACT) to reduce the risks to below significance. 4. Install other than TBACT air pollution control devices or process operation modifications. 5. Address Diesel vehicle engines as listed below.

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Onsite Diesel Truck Activities (including transport refrigeration units)	Idling Mitigation Measures: 1. Move source location to provide effective buffer zone. 2. Establish truck parking restrictions. 3. Provide utility hook-ups for trucks that need to cool their load. 4. Limit truck idling to <5 minutes (State law limits to 5 minutes of idling, and includes various exemptions). 5. Require Trucks to operate an Auxiliary Power Unit. 6. Require the installation of electrical hookups at loading docks and the connection of trucks equipped with electrical hookups to eliminate the need to operate diesel-powered TRUs at the loading docks. Onsite Truck Traveling Emissions: 1. Move source location to provide effective buffer zone. 2. Restrict operation to 2007 model year or newer trucks. 3. Require or provide incentives to use Diesel Particulate Filters for truck engines. 4. Re-route truck traffic by adding alternate access for truck traffic or by restricting truck traffic on certain sensitive routes. 5. Improve traffic flow by signal synchronization. 6. Implement incentive for improved communications of fluctuating demand forecasts for labor and equipment among carriers and operators.
High-traffic road vehicle emissions impacting adjacent receptors	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Improve traffic flow by signal synchronization. 3. Plant vegetation between receptor and roadway. 4. Construct wall barriers between receptor and roadway. 5. Install newer electrostatic filters in adjacent receptor buildings. 6. Fund "clean" street sweepers. 7. Improve road infrastructure to facilitate improved traffic flow without inducing capacity. 8. Improve alternative transportation options
Freeway vehicle emissions impacting adjacent receptors	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Plant vegetation between receptor and roadway. 3. Construct wall barriers between receptor and roadway. 4. Install newer electrostatic filters in adjacent receptor buildings. 5. Improve road infrastructure to facilitate improved traffic flow.
Marine Vehicles (e.g., recreational boating, commercial marine operations, hoteling operations, loading and unloading services)	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. Require or provide incentives to install add-on Diesel Particulate Matter control devices or cleaner engines or boilers. 3. Require use of electric power when berthed. 4. Require cleaner fuels. 5. Limit vessel speed.

Source Category	Mitigation Measure (listed in order of effectiveness by category)
Railroad (i.e., switch yards, maintenance yards, intermodal centers)	1. Move receptors or source to provide effective buffer zone between the source and the receptor. 2. When ambient temperatures are above 50 deg F, minimize locomotive engine idling by shutting down and re-starting engines. 3. Require Idle Reduction Technologies - The rail industry has developed and designed a new Auxiliary Power Unit (APU) system that provides power during idling conditions and shuts down the main locomotive engine. Installing APU system reduces locomotive PM emissions by 84 percent. 4. Require new engine technologies be applied to the engines - Modifying fuel injectors, which includes fuel injection pressure, fuel spray pattern, injection rate and timing, has been found to reduce emissions from locomotive diesel engines. 5. Require hybrid switcher locomotives. 6. Require use of locomotive technology that meets or exceeds the latest EPA emission regulations for locomotives. 7. Apply the 1998 Railroad MOU for South Coast Air Basin. 8. Apply the 2005 Statewide MOU for Rail Yard Risk Reduction.

8.4 Mitigation Monitoring and Reporting

8.4.1 Primary Mitigation Measures

As part of CEQA environmental review procedures, Pubic Resources Code Section 21081.6 requires a public agency to adopt a monitoring and reporting program for assessing and ensuring efficacy of mitigation measures applied to the proposed project. Specifically, the lead or responsible agency must adopt a reporting or monitoring program for mitigation measures incorporated into a project or imposed as conditions of approval. The program must be designed to ensure compliance during project implementation. As stated in Public Resources Code, Section 21081.6 (a) (1):

"The public agency shall adopt a reporting or monitoring program for the changes made to the project or conditions of project approval, adopted in order to mitigate or avoid significant effects on the environment. The reporting or monitoring program shall be designed to ensure compliance during project implementation. For those changes which have been required or incorporated into the project at the request of a responsible agency or a public agency having jurisdiction by law over natural resources affected by the project, that agency shall, if so requested by the lead agency or a responsible agency, prepare and submit a proposed reporting or monitoring program."

This requirement is intended to assure that mitigation measures included as conditions of project approval are indeed implemented. A mitigation monitoring and reporting program should include the following components:

- A description of each mitigation measure adopted by the Lead Agency.
- The party responsible for implementing each mitigation measure.
- A schedule for the implementation of each mitigation measure.
- The agency or entity responsible for monitoring mitigation measure implementation.
- Criteria for assessing whether each measure has been implemented.
- Enforcement mechanism(s).

The mitigation monitoring and reporting program is not required to be included in the environmental document, but its inclusion will encourage the Lead Agency and other entities to specifically consider the feasibility and effectiveness of each mitigation measure while the environmental analysis is still underway. If a responsible agency or any agency having jurisdiction over natural resources affected by the project proposes mitigation measures, the Lead Agency may require that agency to prepare a monitoring and reporting program for those mitigation measures.

8.4.2 Contingency Mitigation Measure

A mitigation implemented to reduce health risk for a particular project may degrade or fail over time. Continuous monitoring and enforcement programs are recommended to ensure the ongoing effectiveness of all mitigation measures over the project life. In the instance that one or more mitigation measures fail or become ineffective, they should be replaced with mitigation measures of equal or greater effectiveness.

Examples of health risk mitigation measures subject to degradation and/or failure include:

- Vegetation barriers, which may die due to natural causes or lack of upkeep;
- Particulate filters, which may become clogged, mechanically damaged or simply reach the end of their design life; and,
- Indoor air filtration systems, which may become clogged or fail completely due to lack of regular maintenance.

9.0 Public Participation

As emphasized in the ARB Handbook, community involvement is an important part of the overall land use approval process. Public participation is critical when proposed projects could create increased health risk to the individuals or the community. To that extent, engaging community members during the initial phase of the project evaluation process provides a communication conduit between impacted individuals, project proponents and the decision makers. This dialog aims to expand the community's overall understanding of the risk assessment process and the resulting health impact values. While the air district is not typically the lead agency for a project undergoing health risk evaluation, it plays a critical role in working with the impacted community to explain the technical modeling tools and assumptions used to calculate the overall risk values that are ultimately provided to local decision makers for approval action.

Active public participation requires engaging individuals in ways that do not require prior knowledge of air pollution issues impacting their communities. Information should be provided to illustrate how a land use decision can affect the health of the community due to emission impacts from Type A or to Type B projects. Due to the overly technical nature of health risk assessments, air districts need to take specific efforts to develop messages and outreach tools that will assist to convey complex issues to a non-technical community. The outreach process needed to build effective community participation requires data, methodologies and formats customized to the needs of the specific community. Depending on the community characteristics cultural barriers, such as translation to another language, need to be assessed prior to conducting community outreach. More importantly, it requires the strong collaboration of community members and agencies that review and approve projects and land uses of the local community.

The ARB Handbook's Table 7-1, Public Participation Approaches includes some general outreach strategies that air districts might consider in designing an outreach program to increase understanding of the air pollution impacts to specific land use projects. Such a program could consider the preparation and presentation of information in a way that supports sensible decision-making and public involvement. In order to build community trust in the health risk assessments being conducted for proposed development, public participation should occur at the initial phases of project evaluation and continue throughout the approval process.

10.0 HRA Issues in the CEQA Process

There are number of issues that have been encountered at the local decision making level that present challenges during the evaluation of health risk impacts from proposed land use projects. To provide more assistance to air districts, lead agencies and community members on how to overcome these challenges, this chapter outlines a few issues that have been encountered during the project evaluation phase, as well as potential solutions to reduce health risk, minimize errors and assist decision makers in their final action.

10.1 Smart Growth

Land use planners, developers, public health agencies and environmentalists alike all struggle with the apparent dichotomy between the public health benefits of limiting development adjacent to freeways and major roadways, and the public health benefits of smart growth strategies which call for development closer in to the urban core, often adjacent to major travel corridors, as a way to reduce overall emissions. Guidance that helps local planners disclose potential risk, and/or seeks to limit development adjacent to freeways and major roadways appears to conflict with smart growth policies, especially when the guidance affects small projects.

A potential solution to this dilemma is the identification and implementation of effective mitigation measures that will help reduce impacts to sensitive receptors, thereby supporting smart growth policies. Table 3 contains program-level TAC mitigation measures. Such measures are applicable to long-range community planning programs such as General Plans and address land use incompatibility at an early stage. These measures are particularly effective in that they can prevent many high-risk projects from being considered or proposed in the first place, thereby eliminating the necessity for project-level mitigation which may not always be feasible or sufficiently effective. Examples of program-level mitigation measures include rezoning vacant land adjacent to freeways, high-volume roadways, ports, railroads or heavy industry to avoid future proposed siting of residential and/or sensitive receptors.

10.2 Less than Lifetime Cancer Risk Exposures

The standard OEHHA 70 year exposure timeframe for HRAs is often vigorously challenged as to whether it is reasonable to base residential cancer risk on a 70 year, 24 hour per day, seven day per week exposure. A 70-year lifetime exposure is a worst-case assumption. Shorter exposure periods can be appropriate depending on the situation. The cancer risks caused by projects impacting offsite workers can be factored in accordance with guidance provide in the State Office of Environmental Health Hazard Assessment provided a document called the *Air Toxic Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments*, August 2003. This guidance document also describes how the exposure period can be reduced from 70 year to shorter periods for Type A projects that will operate for periods less than 70 years. This information is also included in the ***Technical Modeling and Risk Assessment Guidance*** component of this document in Attachment 1.

10.3 Mitigating Roadway Toxics

As discussed above, lead agencies often struggle with requiring mitigation when, due to a lack of a threshold, the roadway toxics impacts are not considered “significant.” At other times, lead agencies are eager to require mitigation, but feel most comfortable being able to point to studies that quantify the actual mitigation levels before asking project proponents to bear the additional costs of the mitigation. In addition, lead agencies often do not feel comfortable asking a project to make changes via implementing mitigation when the project complies with existing zoning requirements and does not request exemptions. While this is a contentious issue, districts may choose to suggest mitigation measures regardless of whether a health risk determination was made by the lead agency.

10.4 Existing Background Risk

Often, environmental documents with site specific HRAs contain lengthy discussions comparing a project’s health risk to the existing background health risk levels, and often, potential project-specific cancer risk levels are expressed as a percentage of the existing background risk without disclosure of the actual additional risk due to the project. It is the actual additional risk due to the project (Type A), or the risk to the project (Type B) that must be disclosed and compared to CEQA significance thresholds.

10.5 Inappropriate Discounting of Risks

Standardized health risk assessment methodologies have been developed to reduce inconsistencies between HRAs and aid in comparing impacts on receptors. However, in practice inappropriate HRA calculations are still carried out and presented as the basis for public disclosure and notification. Such inappropriate HRA calculations are most often made in an attempt to present reduced risk values compared to the higher results produced by standard methodologies. This is a significant concern, especially with respect to health risks associated with locating sensitive land uses in proximity to freeways and other high traffic roadways, where even the standardized HRA modeling methods may not thoroughly characterize all the health risk associated with nearby exposure to traffic generated pollutants.

Inappropriate HRA methodologies often result in protracted controversy, which is sometimes played out in the public arena - for example, at project approval hearings. To minimize these situations, the HRA preparer should adhere to the standard risk calculation methodologies set forth by OEHHA, the Air Resources Board, and the local air district, and as described in this document.

Examples of some mistakes to avoid are described in the following paragraphs.

- One inappropriate calculation is to calculate the cancer risk using the 70-year exposure timeframe, but then reduce the risk values by dividing the risk values by the number of receptors in the subdivision. Doing so is misleading and not scientifically supported. Potential cancer risk should be expressed as probability per million, based upon OEHHA recommendations.

- For Type A projects, it is also inappropriate to present risk values as a percentage of some existing risk value, such as the existing background risk. Often this is done in an attempt to persuade readers that the project specific risk is of little consequence because the increased risk is small compared to the background risk. In cases where project specific risk is compared to other risks or expressed as a percentage of the existing background, it should be made clear that the project specific risk is in addition to the existing background risk.

- Another inappropriate calculation sometimes included in risk assessments is to base emissions on emission factors that may result from future actions, such as emission reduction rules that have not yet gone into effect, or expected emission reductions due to expected market forces.

10.6 Misleading Comparison of Cancer Risks

Comparing cancer risks can be misleading in a CEQA document. Some CEQA documents discuss a variety of cancers and the prevalence of it in our population. It's sometimes stated, for example, that currently throughout the United States, one in three or four persons will experience cancer sometime during their lifetime. This can be a misleading statistic if it is used to imply that the incremental probability of increased cancer cases due to toxic airborne emissions are very small compared to the overall probability of cancer. For example, a Health Risk Assessment may find that the increased probability of cancer cases is 200 in one million for certain sensitive receptors located near a busy freeway. To compare that HRA result with the overall population's cancer incidence would discount the risk unfairly. The CEQA document should disclose the risk without any such comparisons.

10.7 "Experts Disagree"

When project proponents submit HRAs and related materials that are developed via methodologies not supported by the air district or OEHHA, protracted controversy can result. One air district noted that, despite comment from OEHHA and ongoing district comments on the inappropriate discounting of a project's HRA results, those results remained unchanged in the Final EIR. The Final EIR discussed the nature of the disagreement, citing Section 15151 of the CEQA Guidelines which states that disagreement among experts "does not make an EIR inadequate, but the EIR should summarize the main points of disagreement among experts." Ultimately, the lead agency will make a land use decision based on their understanding. But for sources that need an air district permit, the applicable air district's risk assessment procedures will apply.

11.0 Conclusion

The study of the impact of toxic air emissions on sensitive receptors is an evolving one. Air districts in the state of California generally have had a consistent way of performing health risk assessments of stationary sources on nearby sensitive receptors (Type A projects). However, with the publication in 2005 of ARB's Handbook, the issue of the effect of mobile sources on sensitive receptors (Type B projects) required air districts to augment their guidance. This CAPCOA guidance reflects the fact that currently, the various air districts in the state have different approaches to the topic. For example, some districts have developed a threshold of significance for these projects and some have not. Despite these differences, this document offers some common guidance about the need to analyze the impacts, to disclose the risk to decision makers and to mitigate it. As health risk analysis tools, methodology, and protocol as developed, the document will be revised.

Attachment 1

Technical Modeling and Risk Assessment Guidance

Prepared by
CAPCOA Planning Managers
HRA Subcommittee

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Preface

The document shows how to model emissions of toxic substances from various source types to determine the cancer risk, acute risk, and noncancer chronic risk impacting nearby receptors. It can also be used to determine the impacts to new receptors (such as housing projects) proposed to be built next to existing sources that emit toxic substances. These guidelines were prepared to assist in complying with the requirements of the California Environmental Quality Act (CEQA). CEQA requires that environmental impacts of a proposed project be identified, assessed, and mitigated (as possible) if the environmental impacts are significant.

This document consists of three components:

- Modeling Guidelines,
- Exposure Assessment Guidelines, and
- Appendices describing how to determine the emissions and risks from common source categories. Examples of these sources categories include:
  - Roadways,
  - Facilities with onsite truck travel and idling,
  - Stationary diesel engines, and
  - Fast food and other restaurants.

The modeling guidelines are based on a document entitled "Provision of Services to Develop Guidance for Air Dispersion Modeling," developed by Dr. Jesse Thé of Lakes Environmental Software. They have been modified to include various air quality dispersion modeling issues pertinent to California, and are based primarily on information found in EPA's Guideline on Air Quality Models (Appendix W of Part 51 of Title 40 of the Code of Federal Regulations). The modeling components are intended to provide insight into recommended modeling approaches and provide consistency in the modeling methods used.

The Exposure Assessment components are based on the procedures developed by the California Office of Environmental Health Hazard Assessment (OEHHA). These calculation methodologies may change over time as the OEHHA refines the methodologies. **It is important that the air district be contacted before any risk assessment calculations are prepared, so that the most current methodologies are applied.**

This document is not designed to provide theoretical background on the models it discusses. Technical documents covering these topics can be easily obtained from several U.S. EPA sources and are listed as references in this document. This document does provide details on performing a successful modeling study including:

- Model Backgrounds and Applicability,
- Model Selection and Study Approach,
- Tiered Approach to Assessing Compliance,
- Model Input Data Requirements,
- Geographical Information,
- Meteorological Data Requirements and Acquisition, and
- Information/Parameters for Inclusion in an Assessment.

Glossary of Terms

AERMAP: The terrain preprocessor for AERMOD, AERMAP allows the use of digital terrain data in AERMOD.

AERMET: The meteorological preprocessor for AERMOD.

AERMIC: American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee.

AERMOD: A new air dispersion model developed by AERMIC. It is intended to replace the ISCST model.

Air Emissions: Release of pollutants into the air from a source.

Albedo: Portion of the incoming solar radiation reflected and scattered back to space.

Ambient Air: Air that is accessible to the public.

AMS: American Meteorological Society.

CAL3QHCR: CAL3QHCR is derived from CAL3QHC which is also derived from CALINE3. CALINE3 is a Carbon Monoxide (CO) model with queuing, hot spot calculations, and a traffic model to calculate delays and queues that occur at signalized intersections. CAL3QHCR is a more refined version requiring local meteorological data.

Calm: Cessation of horizontal wind.

Complex Terrain: Terrain exceeding the height of the stack being modeled.

DEM: Digital Elevation Model. Digital files that contain terrain elevations typically at a consistent interval across a standard region of the Earth's surface.

Dispersion Model: A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

Emission Factor: An estimate of the rate at which a pollutant is released to the atmosphere

Flagpole Receptor: Any receptor located above ground level.

Inversion: An increase in ambient air temperature with height. This is the opposite of the usual case.

ISCST: Industrial Source Complex – Short Term Dispersion Model.

Lee side: The lee side of a building is the side that is sheltered from the wind.

Mixing Height: Top of the neutral or unstable layer and also the depth through which atmospheric pollutants are typically mixed by dispersive processes.

Monin-Obukhov Length: A constant, characteristic length scale for any particular example of flow. It is negative in unstable conditions (upward heat flux), positive for stable conditions, and approach infinity as the actual lapse rate for ambient air reaches the dry adiabatic lapse rate.

NWS: National Weather Service. A U.S. government organization associated with the National Oceanic and Atmosphere Administration.

PCRAMMET: Meteorological program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 FORMAT) and hourly surface weather observations (CD-144 format) for use in dispersion models such as ISCST, CRSTER, MPTER and RAM.

Preferred Model: A refined model that is recommended for a specific type of regulatory application.

Primary Pollutant: Substance emitted from the source.

Regulatory Model: A dispersion model that has been approved for use by the regulatory offices of the U.S. EPA, specifically one that is included in Appendix A of the Guideline on Air Quality Models (Revised), such as the ISC model.

Screening Technique: A relatively simple analysis technique to determine if a given source is likely to pose a threat to air quality. Concentration estimates from screening techniques are conservative.

Simple Terrain: An area where terrain features are all lower in elevation than the top of the stack of the source.

Upper Air Data (soundings): Meteorological data obtained from balloon-borne instrumentation that provides information on pressure, temperature, humidity and wind away from the surface of the earth.

U.S. EPA: United States Environmental Protection Agency.

Worst Case: The maximum exposure, dose, or risk that can conceivably happen to specific receptors.

Chapter 1. A Tiered Approach to Risk

1.0 Modeling and Exposure Assessment Tiers Overview

Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. Both the modeling component and the exposure assessment component are based on a tiered method. This document shows how to:

- Model the downwind concentrations of pollutants using each of the four modeling tiers (levels), then
- Use tiers to prepare the exposure assessment part of the risk assessment.

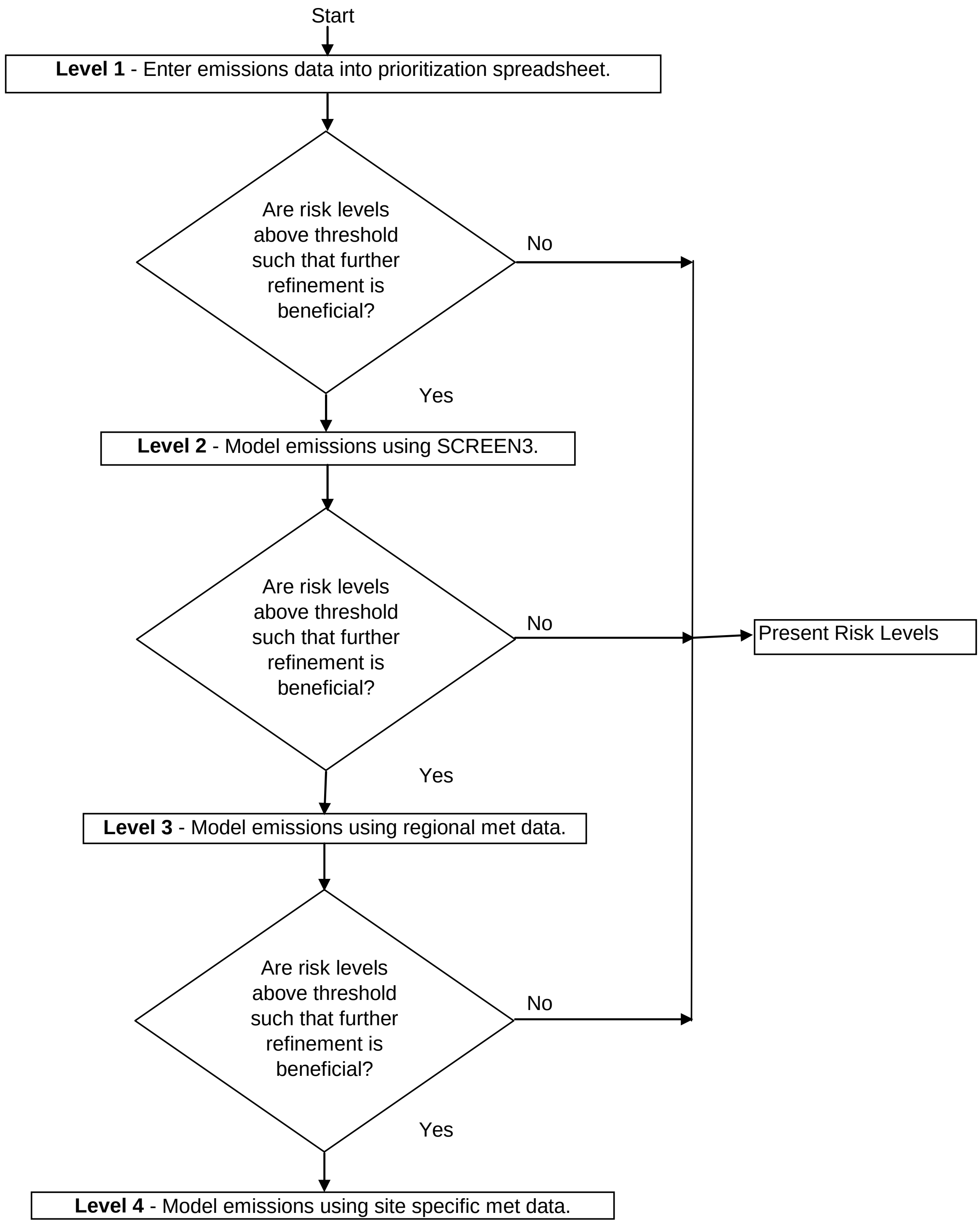
The models described in the document include:

- Screening models:
  - SCREEN3, and
  - AERSCREEN

- Refined models:
  - ISCST3,
  - ISC-PRIME, and
  - AERMOD
  - CAL3QHCR

A tiered approach to air dispersion modeling is presented in Figure 1. The level of effort generally increases with level number. It should be noted that any of the tiers or levels can provide risk assessment results, although the higher the tier or level the more accurate the results. Linear progression through each tier or level is not necessary. For example, a refined modeling analysis can be prepared without first preparing a screening analysis.

Figure 1 - Tiered approach to modeling for risk assessments:



1.1 Dispersion Models used for each TIER:

1.1.1 Level 1 – Prioritization Screening

A Level 1 analysis utilizes the CAPCOA prioritization methodology (http://www.arb.ca.gov/ab2588/RRAP-IWRA/priguide.pdf), or an air district's prioritization procedure to determine the potential impact from a facility's operation based on the quantity of emissions emitted and proximity to a receptor(s) and release height. But before preparing a Level 1 analysis, the air district should be consulted. A prioritization calculation is a screening tool that identifies whether a source has the possibility to exceed a prioritization score that represents the need for further analysis, usually this level is a score of ten

The following input data must be included in a prioritization calculation:

- The nearest receptor (residential or offsite worksite) must be used to represent all other receptors; regardless of the location of the receptor to the proposed project.
- Emissions should represent the "worst case" emissions estimate. Worst case for cancer risk is based on 70 years of exposure. Worst case for acute adverse health effects is based on the hour with the highest emissions. Worst case for chronic adverse health effects is based on the annual average emissions. These emissions should be based on actual expected worst case emissions, rather than a theoretical potential to emit estimate. The emissions should be routine and predictable.
- The prioritization calculations must follow those in the CAPCOA Prioritization Guidelines or the district's prioritization guidelines.

1.1.2 Level 2 - SCREEN3 Modeling

A Level 2 analysis is a screening level analysis using the U.S. EPA's SCREEN3 model, which includes all potential worst-case meteorological conditions. If a risk assessment based on SCREEN3 modeling shows risks below significance thresholds, then there is no need for additional modeling.

Note: At the time of writing this document, AERSCREEN remains unavailable and is currently in development. When AERSCREEN becomes available, it may be substituted for SCREEN3 in the multi-tier approach.

1.1.3 Level 3 – CAL3QHCR, ISCST3, or AERMOD modeling using Regional Met Data

A Level 3 analysis is a more refined analysis using CAL3QHCR, ISCST3, or AERMOD and regional hourly meteorological data. Contact the District regarding the availability of preprocessed meteorological data sets.

1.1.4 Level 4 - CAL3QHCR, ISCST3 or AERMOD Modeling using Site Specific Met Data

A Level 4 analysis is a more refined analysis using CAL3QHCR, ISCST3, or AERMOD and site specific hourly meteorological data. Contact the District regarding the availability of preprocessed meteorological data sets. This data typically must be pre-processed by the modeler or a meteorological data provider such as the National Weather Service (NWS). Local meteorological data sets include site-specific parameters and meteorological characteristics that directly represent the site of consideration with a greater level of detail than most regional data sets. A Level 4 analysis also encompasses modeling analyses that make use of any alternative models.

1.2 Exposure Assessment Tiers

When substances are emitted that can affect intake pathways other than inhalation, the use of the latest version of the Hot Spots Analysis and Reporting Program (HARP) modeling and risk assessment software is recommended. The latest version of HARP can be downloaded at http://www.arb.ca.gov/toxics/harp/harp.htm. If the emissions consist of only substances that enter the body through the inhalation pathway, other risk assessment methodologies consistent with the methodologies approved for the Air Toxics "Hot Spots" Emissions Inventory and Risk Assessment Program can be used. Most substances enter the body only through the inhalation pathway. Ingestion, dermal absorption, and other pathways are not usually significant pathways for emitted gases. Therefore, if all the substances impacting receptors only enter the body through inhalation, then the risk assessment preparation effort can be minimized. If just one substance can enter the body through another pathway, then a multipathway analysis must be prepared. An exception to this is diesel particulate, which is modeled only through the inhalation pathway.

The toxicity values that are used must be those that the California Office of Environmental Health Hazard Assessment (OEHHA) has identified. These toxicity values can be found at (http://www.arb.ca.gov/toxics/healthval/healthval.htm). If a substance is emitted and toxicity values have not been identified by OEHHA, other sources of data can be applied.

Although more detailed information can be found by directly reviewing the latest OEHHA risk assessment procedures, what follows is a description of the tiers associated with a multipathway exposure assessment. Additional information can be found at ARB's HARP websites and OEHHA's websites.

There are four basic tiers or levels that can be applied in the exposure assessment portion of the risk assessment:

Tier 1 -Point Estimate, Default Intake Values
The easiest tier to complete assumes various intake default values, and calculates the risk as a single value rather than a distribution curve.

Tier 2 -Point Estimate, Site Specific Intake Values
The next tier requires site specific information to determine intake values, but continues to apply single intake values to the risk values.

Tier 3 -Distribution Curve Risk Estimate, Default Distribution Curve Intake Values
The third tier applies default distribution curve values to determine a distribution curve risk result.

Tier 4 -Distribution Curve Risk Estimate, Site Specific Distribution Curve Intake Values

The fourth tier applies site specific distribution curve values to determine a distribution curve risk result.

1.3 Exposure Duration Adjustment (Cancer Only)

Cancer risk calculations are based on a 70 year lifetime exposure. In some limited cases, it may be appropriate to also use either 9 or 40 years exposure in the calculation. The 9 year exposure scenario is based on exposure to children during the first 9 years of life. Some districts use the 9 year exposure scenario to model short term projects The 40 year exposure scenario can be used to represent the risk to nearby workers. The local district should be contacted before using any exposure duration less than 70 years. In no case should an exposure period of less than 9 years be used.

Chapter 2. Application of Models

2.0 Modeling Overview

Air dispersion modeling is the mathematical estimation of pollutant impacts from emissions sources within a study area. Several factors impact the fate and transport of pollutants in the atmosphere including, but not limited to meteorological conditions, site configuration, emission release characteristics, and surrounding terrain.

2.1 Preferred Models

Preferred Models are defined as standard models that are expected to be used for air quality studies. Alternative models may be used if conditions warrant their use. These are outlined in Section 2.3. The U.S. EPA's preferred models include SCREEN3 for screening analyses and AERMOD for refined modeling analyses. For CEQA, CAL3QHCR, ISCST, and ISC-PRIME may also be used.

For efficient risk assessment processing, the district should be consulted to determine the appropriateness of the model proposed for use. A brief overview of each of these models can be found below. For appropriate model selection, please review the section that outlines:

2.1.1 AERMOD

The American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Regulatory Model, AERMOD[1,2,3] was specially designed to support the U.S. EPA's

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[1] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AMS/EPA Regulatory Model – AERMOD. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[2] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

[3] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

regulatory modeling programs. AERMOD is the next-generation air dispersion model that incorporates concepts such as planetary boundary layer theory and advanced methods for handling complex terrain. AERMOD was developed to replace the Industrial Source Complex Model-Short Term (ISCST3) as U.S. EPA's preferred model for most small-scale regulatory applications.[4,5] The latest versions of AERMOD also incorporate the Plume Rise Model Enhancements (PRIME) building downwash algorithms, which provide a more realistic handling of downwash effects than previous approaches.

The PRIME model was designed to incorporate two fundamental features associated with building downwash:

- Enhanced plume dispersion coefficients due to the turbulent wake.
- Reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake.

AERMOD contains basically the same options as the ISCST3 model with a few exceptions, which are described below:

- Currently, the model only calculates concentration values. Dry and wet deposition algorithms were not implemented at the time this document was written.
- AERMOD requires two types of meteorological data files, a file containing surface scalar parameters and a file containing vertical profiles. These two files are produced by the U.S. EPA AERMET meteorological preprocessor program[4].
- For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. The U.S. EPA AERMAP terrain-preprocessing program[6] can be used to generate hill height scales as well as terrain elevations for all receptor locations.

The options AERMOD has in common with ISCST3 and ISC-PRIME are described in the next section.

2.1.2 ISCST3 & ISC-PRIME Overview

The ISCST3 dispersion model is a steady-state Gaussian plume model, which can be used to assess pollutant concentrations and/or deposition fluxes from a wide variety of sources associated with an industrial source complex. The ISCST3 dispersion model from the U.S. EPA was designed to support the EPA's regulatory modeling options, as specified in the Guidelines on Air Quality Models (Revised)[7].

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[4] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[5] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[6] U.S. Environmental Protection Agency, 1998. Revised Draft - User's Guide for the AERMOD Terrain Preprocessor (AERMAP). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[7] U.S. Environmental Protection Agency, 1986. Guidelines on Air Quality Models (Revised) and Supplement A. EPA-450/2-78-027R. U.S. Environmental Protection Agency, Research Triangle Park, NC.

The PRIME algorithms have been integrated into the ISCST3 (Version 96113) model. This integrated model is called ISC-PRIME[8]. The ISC-PRIME model uses the standard ISCST3 input file with a few modifications in the Source Pathway section. These modifications include three new inputs that which are used to describe the building/stack configuration.

To be able to run the ISC-PRIME model, you must first perform building downwash analysis using the Building Profile Input Program (BPIP). For more information on building downwash please refer to Section 3.8 - Building Impacts.

Some of the ISCST3/ISC-PRIME modeling capabilities are:

- ISC-PRIME model may be used to model primary pollutants and continuous releases of toxic and hazardous pollutants.
- ISC-PRIME model can handle multiple sources, including point, volume, area, and open pit source types. Line sources may also be modeled as a string of volume sources or as elongated area sources.
- Source emission rates can be treated as constant or may be varied by month, season, hour-of-day, or other periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources.
- The model can account for the effects of aerodynamic downwash due to nearby buildings on point source emissions.
- The model contains algorithms for modeling the effects of settling and removal (through dry deposition) of large particulates and for modeling the effects of precipitation scavenging for gases or particulates.
- Receptor locations can be specified as gridded and/or discrete receptors in a Cartesian or polar coordinate system.
- ISC-PRIME incorporates the COMPLEX1 screening model dispersion algorithms for receptors in complex terrain.
- ISC-PRIME model uses real hourly meteorological data to account for the atmospheric conditions that affect the distribution of air pollution impacts on the modeling area.
- Results can be output for concentration, total deposition flux, dry deposition flux, and/or wet deposition flux. Until AERMOD has incorporated deposition, ISC-PRIME would be the preferred model for applications such as risk assessment where deposition estimates are required.

Unlike AERMOD, the ISC models do not contain a terrain pre-processor. As a result, receptor elevation data must be obtained through alternative means. The use of an inverse distance algorithm for interpolating representative receptor elevations is an effective method.

[8] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

2.1.3 SCREEN3 Overview

The SCREEN3 model was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. These estimates are based on the document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources"[9].

SCREEN3, version 3.0 of the SCREEN3 model, can perform all the single source short-term calculations in the EPA screening procedures document, including:

- Estimating maximum ground-level concentrations and the distance to the maximum.
- Incorporating the effects of building downwash on the maximum concentrations for both the near wake and far wake regions.
- Estimating concentrations in the cavity recirculation zone.
- Estimating concentrations due to inversion break-up and shoreline fumigation.
- Determining plume rise for flare releases.

EPA's SCREEN3[10] model can also:

- Incorporate the effects of simple elevated terrain (i.e., terrain not above stack top) on maximum concentrations.
- Estimate 24-hour average concentrations due to plume impaction in complex terrain (i.e., terrain above stack top) using the VALLEY model 24-hour screening procedure.
- Model simple area sources using a numerical integration approach.
- Calculate the maximum concentration at any number of user-specified distances in flat or elevated simple terrain, including distances out to 100 km for long-range transport.
- Examine a full range of meteorological conditions, including all stability classes and wind speeds to find maximum impacts.
- Include the effects of buoyancy-induced dispersion (BID).
- Explicitly calculate the effects of multiple reflections of the plume off the elevated inversion and off the ground when calculating concentrations under limited mixing conditions.

2.1.4 CAL3QHCR Overview

"CAL3QHCR is a refined version of the original CALINE (California Line Source Dispersion Model) that was developed as a modeling tool to predict roadside CO concentrations. CAL3QHCR can be used to estimate ambient PM concentrations and to process hourly meteorological data over a year, hourly emissions, traffic volume, and signal data. The model can be obtained from EPA at http://www.epa.gov/scram001/dispersion_prefrec.htm.

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[9] U.S. Environmental Protection Agency, 1992: Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised, October 1992 (EPA-450/R-92-019),
User's Guide for the Industrial Source Complex (ISC2) Dispersion Models: Volume II—Description of Model Algorithms. U.S. Environmental Protection Agency, OAQPS, Research Triangle Park, NC 27711. Publication No. EPA-450/4-92-008b.

[10] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2.2 ISC and AERMOD Model Comparison

The ISC and AERMOD models share several similarities:

- Both are steady state plume models
- AERMOD input and output are intentionally similar to ISC for ease of use

AERMOD is a next-generation model, and while input and output may share similarities in format, there are several differences as detailed in the table below.

Table 2 – Differences between ISCST3 and AERMOD

ISCST3	AERMOD
Plume is always Gaussian	Plume is non-Gaussian when appropriate
Dispersion is function of six stability classes only	Dispersion is function of continuous stability parameters and height
Measured turbulence cannot be used	Measured turbulence can be used
Wind speed is scaled to stack height	Calculates effective speed through the plume
Mixing height is interpolated	Mixing height is calculated from met data
Plume either totally penetrates the inversion, or not at all	Plume may partially penetrate the inversion at the mixing height
Terrain is treated very simplistically	More realistic terrain treatment, using dividing streamline concept
Uses single dispersion for all urban areas	Adjusts dispersion to size of urban area
Cannot mix urban and rural sources	Can mix urban and rural sources

2.3 Alternative Models

Alternative models may also be accepted to determine health risks for CEQA projects. Please see the Guideline on Air Quality Models (published as Appendix W of 40 CFR Part 51) for terms of appropriate use and required supporting explanations. **Please note,** pre-approval is normally sought from the district before using alternative models.

2.4 Model Validations

The U.S. EPA ISCST3 / ISC-PRIME and AERMOD models are some of the most studied and validated models in the world. Studies have typically demonstrated good correlation with real-world values. AERMOD particularly handles complex terrain very well, closely matching the trends of field observations from validation studies.

ISC-PRIME differs from ISCST3 primarily in its use of the PRIME downwash algorithm. A model evaluation study was carried out under the auspices of the Electric Power Research Institute

(EPRI). The report[11] is available from EPRI and from the U.S. EPA SCRAM website http://www.epa.gov/scram001. The report analyzed comparisons between model predictions and measured data from four databases involving significant building downwash. This is in addition to 10 additional databases that were used during the development of ISC-PRIME. The study found that ISC-PRIME performed much better than ISCST3 under stable conditions, where ISCST3 predictions were very conservative (high). In general, ISC-PRIME was unbiased or somewhat over predicting. Also, ISC-PRIME showed a statistically better performance result than ISCST3 for each database in the study.

The U.S. EPA performed the evaluation of AERMOD. A summary of the evaluation studies was prepared by Paine, et al[12]. This and more detailed reports can be found at the U.S. EPA SCRAM website. Five databases were used during the development of the model. Five additional non-downwash databases were used in the final evaluation. For cases involving building downwash, four developmental databases were used to check the implementation of PRIME into AERMOD as it was accomplished. Three additional databases were reserved for the final evaluation. AERMOD remained unbiased for complex terrain databases as well as flat terrain, while ISCST3 severely over-predicted for complex terrain databases.

Chapter 3. MODEL INPUT DATA

3.0 Comparison of Screening and Refined Model Requirements

The use of the screen model requires the least amount of effort to calculate risks but produces the most conservative results. The SCREEN3 model input requirements are described in the next section.

Refined air dispersion modeling using the U.S. EPA AERMOD or ISCST3 / ISC-PRIME models can be broken down into a series of steps. These are outlined in Sections 3.2 and 3.3.

A general overview of the process typically followed for performing an air dispersion modeling assessment is present in Figure 3.1 below. The figure is not meant to be exhaustive in all data elements, but rather provides a picture of the major steps involved in an assessment.

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[11] Paine, R.J. and F. Lew, 1997. Results of the Independent Evaluation of ISCST3 and ISC-PRIME. EPRI Paper No. TR2460026, WO3527-02, Final Report. Electric Power Research Institute, Palo Alto, CA 94304.

[12] Paine, R.J., R.W. Brode, R.B. Wilson, A.J. Cimorelli, S.G. Perry, J.C. Weil, A. Venkatram, W.D. Peters and R.F. Lee, 2003. AERMOD: The Latest Features and Evaluation Results. Paper # 69878 presented at the Air and Waste Management Association 96th Annual Conference and Exhibition, June 22-26, 2003. Air and Waste Management Association, Pittsburgh, PA 15222.

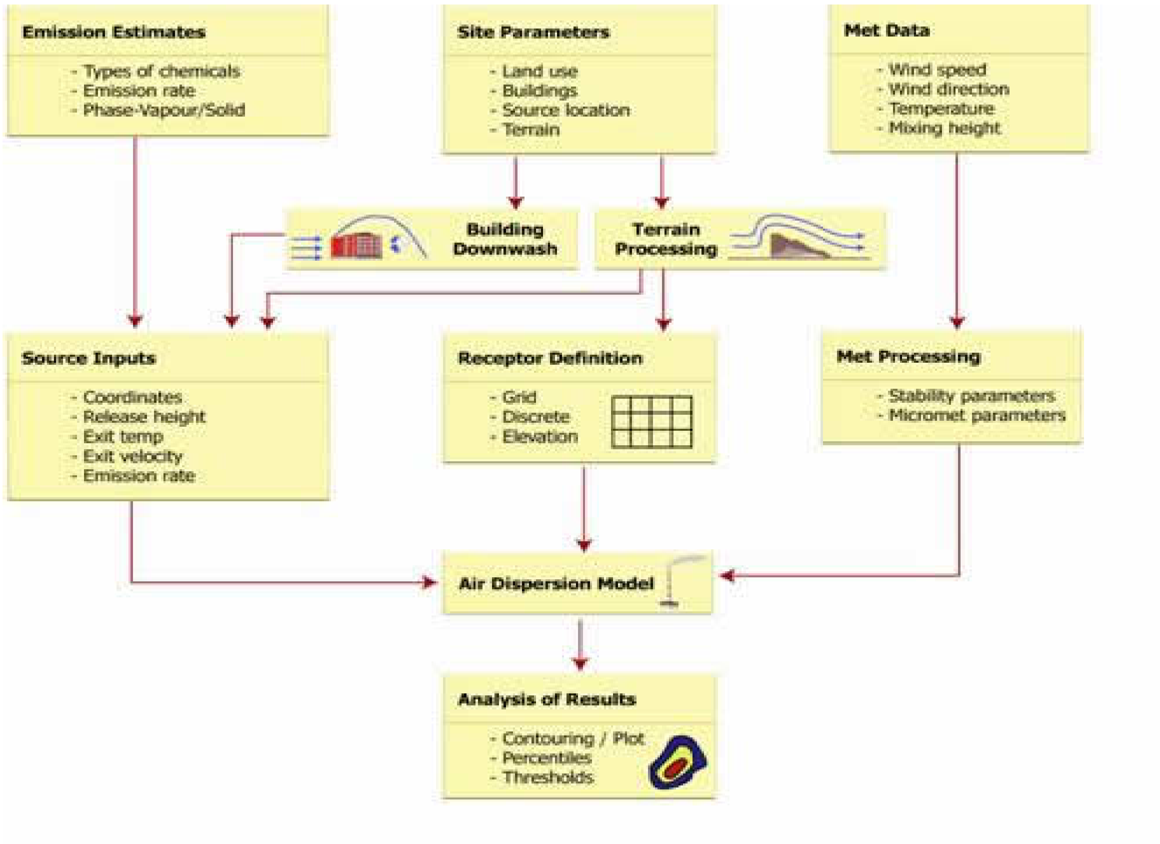

Figure 3.1 - Generalized process for performing a refined air dispersion modeling assessment.

3.1 SCREEN3

The SCREEN model[13] was developed to provide an easy-to-use method of obtaining pollutant concentration estimates. This model is normally used as an initial screening tool to assess **single sources** of emissions. SCREEN3 can be applied to multi-source facilities by conservatively summing the maximum concentrations for the individual emissions sources.

To perform a modeling study using SCREEN3, data for the following input requirements must be supplied:

- Source Type (Point, Flare, Area or Volume)
- Physical Source and Emissions Characteristics.
  (For example, a point source requires:
  - Emission Rate
  - Stack Height
  - Stack Inside Diameter
  - Stack Gas Exit Velocity
  - Stack Gas Exit Temperature
  - Ambient Air Temperature

[13] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

    - Receptor Height Above Ground
- Meteorology: SCREEN3 can consider all conditions, or a specific stability class and wind speed can be provided.
    - If a single wind speed/stability combination is used, the predicted concentration should only be used to determine hourly concentration, as the factors used to convert hourly concentration to annual concentrations are only valid when SCREEN3 is ran with full meteorological data selected.
- Building Downwash: If this option is used then building dimensions (height, length and width) must be specified.
- Terrain: SCREEN3 supports flat, elevated and complex terrain. If elevated or complex terrain is used, distance and terrain heights must be provided.
- Fumigation: SCREEN3 supports shoreline fumigation. If used, distance to shoreline must be provided.

As can be seen above, the input requirements are minimal to perform a screening analysis using SCREEN3. The refined models discussed in the next sections, have much more detailed options allowing for greater characterization and more representative results.

3.2 AERMOD

The supported refined models have many input options, and are described further throughout this document as well as in their own respective technical documents[14,15,16,17]. An overview of the modeling approach and general steps for using each refined model are provided below. The general process for performing an air dispersion study using AERMOD includes:

- Meteorological Data Processing (AERMET is used for this)
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME is used for this) – Project requires source and building information
- Final site characterization – complete source and receptor information
- AERMAP – Perform terrain data pre-processing for AERMOD air dispersion model if required.
- AERMOD – Run the model.
- Visualize and analyze results.

[14] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

[15] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[16] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume II – Description of Algorithms. U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Available from website http://www.epa.gov/scram001 as of January 2003.

[17] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.

As can be seen above, the AERMOD modeling system is comprised of 3 primary components as outlined below and illustrated in Figure 3.2:

- AERMET – Meteorological Data Preprocessor
- AERMAP – Digital Terrain Preprocessor
- AERMOD – Air dispersion model

To successfully perform a complex terrain air dispersion modeling analysis-using AERMOD, you must complete the processing steps required by AERMET and AERMAP. See Appendix A for more information on meteorological data.

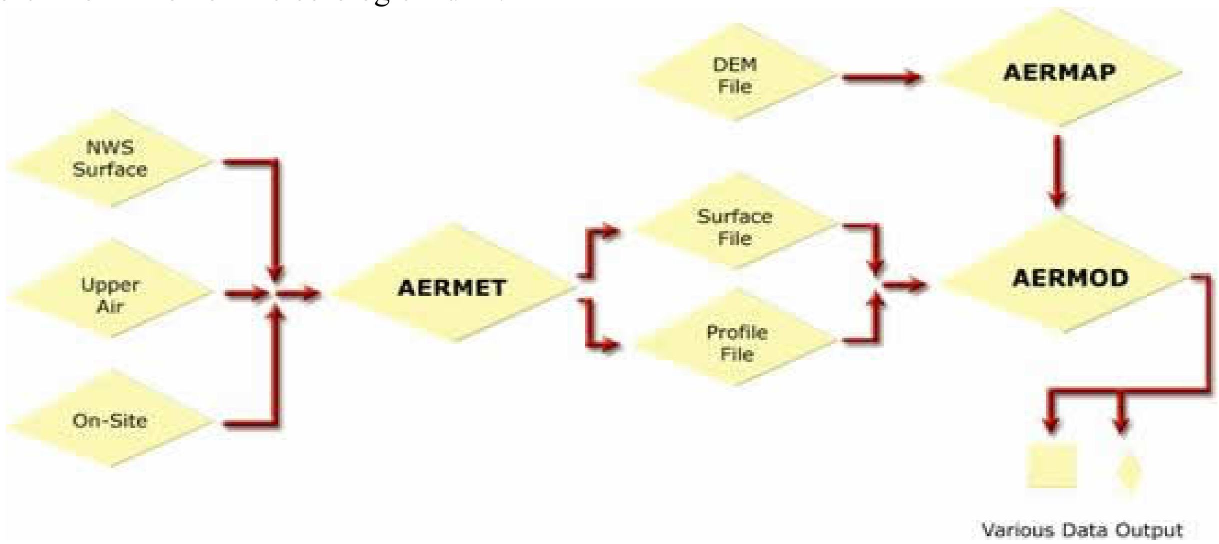

Figure 3.2 - The AERMOD air dispersion modeling system.

3.3 ISC-PRIME

The ISC-PRIME model has very similar input requirements when compared with AERMOD. These include:

- Meteorological Data Processing - PCRAMMET
- Obtain Digital Terrain Elevation Data (If terrain is being considered)
- Building Downwash Analysis (BPIP-PRIME) – Project requires source and building information
- Final site characterization – complete source and receptor information
- ISC-PRIME – Run the ISC-PRIME model.
- Visualize and analyze results.

As can be seen above, the ISC and AERMOD models follow a very similar approach to perform an air dispersion modeling project. The primary difference between running the ISC and AERMOD models is that ISC does not require a terrain preprocessor, such as AERMAP. Furthermore, ISC relies on a different meteorological preprocessor known as PCRAMMET. The components of meteorological data pre-processing using PCRAMMET are illustrated in Figure 3.3 below. For a complete outline on how to obtain meteorological data, please see Appendix A.

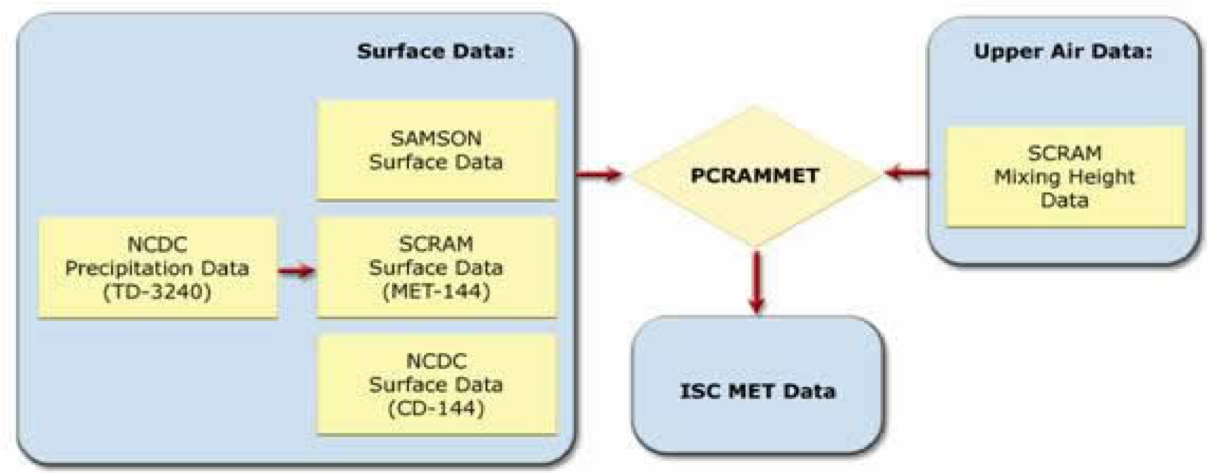

Figure 3.3 - Meteorological data pre-processing flow diagram for the U.S. EPA ISC models

3.4 Regulatory and Non-Regulatory Option Use

The ISC-PRIME and AERMOD models contain several regulatory options, which are set by default, as well as non-regulatory options. Depending on the model, the non-regulatory options can include:

- No stack-tip downwash (NOSTD)
- Missing data processing routine (MSGPRO)
- Bypass the calms processing routine (NOCALM)
- Gradual plume rise (GRDRISM)
- No buoyancy-induced dispersion (NOBID)
- Air Toxics Options (TOXICS)
- By-pass date checking for non-sequential met data file (**AERMOD**)
- Flat terrain (FLAT) (**AERMOD**)

The use of any non-regulatory default option(s) must be justified through a discussion in the modeling report and approved by the district before performing any modeling runs. Regulatory models that account for elevated terrain should be used when appropriate.

3.5 Coordinate System

Any modeling assessment will require a coordinate system to be defined in order to assess the relative distances from sources and receptors and, where necessary, to consider other geographical features. Employing a standard coordinate system for all projects increases the efficiency of the review process while providing real-world information about the site location. The AERMOD model's terrain pre-processor, AERMAP, requires digital terrain in Universal Transverse Mercator (UTM) coordinates. The UTM system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude.

For more information on coordinate systems and geographical information inputs, see Section 6.

3.6 Averaging Times

A key advantage to the more refined air dispersion models is the ability to compare effects-based standards with appropriate averaging times. OEHHA assigns different exposure periods to different health effects. For example, cancer risks are assessed for "lifetime" exposure. Chronic noncancer health effects are calculated for long-term, but not necessarily lifetime exposures. Acute noncancer health effects are usually based on a maximum 1-hour exposure, but there are some exceptions, such as benzene which is based on a maximum 6 hour exposure. Use of effects-based averaging times enables a contaminant to be assessed using modeled exposure concentrations for the appropriate averaging period for that contaminant and endpoint.

In addition to enabling the use of appropriate model averaging times, refined models allow the input of variable emission rates, where appropriate, for assessing concentrations over different averaging times. That is, a source that operates only during certain hours of the day can be modeled using only those hours of meteorology data.

The ability to assess air quality using the most appropriate effects-based averaging time means the refined air dispersion models provide a more representative assessment of health and environmental impacts of air emissions from a facility.

3.7 Defining Sources

3.7.1 Point, Area, Volume, and Flare Emissions Release Parameters Required for each Model

The U.S. EPA SCREEN3, ISCST3, ISC-PRIME and AERMOD models support a variety of source types that can be used to characterize most emissions within a study area. The following sections outline the primary source types and their input requirements for both screening and refined models. Detailed descriptions on the input fields for these models can be found for SCREEN3 in U.S. EPA[18], for ISC-PRIME in U.S. EPA[19,20], and for AERMOD in U.S. EPA[21].

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[18] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[19] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[20] U.S. Environmental Protection Agency, 1997. Addendum to ISC3 User's Guide – The Prime Plume Rise and Building Downwash Model. Submitted by Electric Power Research Institute. Prepared by Earth Tech, Inc., Concord, MA.
[21] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

3.7.1.1 Point Sources

Point sources are typically used when modeling releases from sources like stacks and isolated vents. Input requirements for point sources include:

SCREEN3

- **Emission Rate** [g/sec]: The emission rate of the pollutant.
- **Stack Height** [m]: The stack height above ground.
- **Stack Inside Diameter** [m]: The inner diameter of the stack.
- **Stack Gas Exit Velocity** [m/s] or Stack Gas Exit Flow Rate [m3/s]: Either the stack gas exit velocity or the stack gas exit flow rate should be given. The exit velocity can be determined from the following formula:

  $Vs = 4*V/(\pi*(d_s\hat{}2))$

  Where,

  V_s = Exit Velocity
  V = Flow Rate
  d_s = Stack Inside Diameter

- **Stack Gas Temperature** [K]: The temperature of the released gas in degrees Kelvin.
- **Ambient Air Temperature** [K]: The average atmospheric temperature (K) in the vicinity of the source. If no ambient temperature data are available, assume a default value of 293 degrees Kelvin (K). For non-buoyant releases, the user should input the same value for the stack temperature and ambient temperature.

AERMOD/ISCST/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters (center of the point source).
- **Y Coordinate**: Enter here the y (north-south) coordinate for the source location in meters (center of the point source).
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if Elevated terrain is being used.
- **Release Height above Ground** [m]: The source release height above the ground in meters.
- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second. Stack Gas Exit Temperature [K]: The temperature of the released gas in degrees Kelvin.
- **Stack Gas Exit Velocity** [g/sec]: The stack gas exit velocity in meters per second or the stack gas flow rate (see above section on SCREEN3).
- **Stack Inside Diameter** [m]: The inner diameter of the stack.

3.7.1.2 Area Sources

Area sources are used to model releases that occur over an area (e.g., landfills, storage piles, slag dumps, and lagoons). SCREEN3 allows definition of a rectangular area, aligned with the north-south axes, while the ISC-PRIME and AERMOD models accept rectangular areas that may also have a rotational angle specified relative to a north-south orientation, as well as a variety of other shapes.

SCREEN3

- **Emission Rate** [g/(s-m^2)]: The emission rate of the pollutant. The emission rate for area sources is input as an emission rate per unit area (g/(s-m^2)).
- **Source Release Height** [m]: The source release height above ground.
- **Longer Side Length of Rectangular Area** [m]: The longer side of the rectangular source in meters.
- **Shorter Side Length of Rectangular Area** [m]: The shorter side of the rectangular source in meters.
- **Wind Direction Search Option**: Since the concentration at a particular distance downwind from a rectangular area is dependent on the orientation of the area relative to the wind direction, the SCREEN model provides the user with two options for treating wind direction. The regulatory default option is "yes" which results in a search of a range of wind directions. See U.S. EPA[22] for more detailed information.

AERMOD/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Y Coordinate**: The y (north-south) coordinate for the vertex (corner) of the area source that occurs in the southwest quadrant of the source. Units are in meters.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground in meters.
- **Emission Rate** [g/(s-m^2)]: Enter the emission rate of the pollutant. The emission rate for Area sources is input as an emission rate per unit area. The same emission rate is used for both concentration and deposition calculations.
- Options for Defining Area: In ISC-PRIME the only option for defining the area is a rectangle or square. The maximum length/width aspect ratio for area sources is 10 to 1. If this is exceeded, then the area should be divided to achieve a 10 to 1 aspect ratio (or less) for all sub-areas. See U.S. EPA[23] for more details on inputting area data. In addition to the rectangular area, AERMOD can have circular or polygon areas defined (see U.S. EPA[24] for details).

[22] U.S. Environmental Protection Agency, 1995. Quality Assurance Handbook for Air Pollution Measurement Systems. Vol. IV, Meteorological Measurements. EPA/600/R-94/038d, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711. Also available from the following website as of February 2003: http://www.epa.gov/scram001.

[23] U.S. Environmental Protection Agency, 1995. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models (Revised), Volume 1. EPA-454/B-95-003a. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[24] Cimorelli, A.J., S.G. Perry, A. Venkatram, J.C. Weil, R.J. Paine, R.B. Wilson, R.F. Lee, W.D. Peters, R.W. Brode, J.O. Paumier, 2002: AERMOD: Description of Model Formulation. U.S. Environmental Protection Agency, EPA-454/R-02-002d (draft dated October 31, 2002). Available from http://www.epa.gov/scram001.

Note: There are no restrictions on the location of receptors relative to area sources. Receptors may be placed within the area and at the edge of an area. The U.S. EPA models (ISCST3, ISC-PRIME, and AERMOD) will integrate over the portion of the area that is upwind of the receptor. The numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor. Therefore, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide.

3.7.1.3 Volume Sources

Volume sources are used to model releases from a variety of industrial sources, such as building roof monitors, fugitive leaks from an industrial facility, multiple vents, and conveyor belts.

SCREEN3

- **Emission Rate** [g/sec]: The emission rate of the pollutant in grams per second (g/s).
- **Source Release Height** [m]: The source release height above ground surface at the center of the volume.
- **Initial Lateral Dimension** [m]: See Table 3.1 below for guidance on determining initial dimensions. Units are meters.
- **Initial Vertical Dimension** [m]: See Table 3.1 below for guidance on determining initial dimensions. Units are meters.

Table 3.1 Summary of Suggested Procedures for Estimating Initial Lateral Dimension ($_{yo}$) and Initial Vertical Dimension ($_{zo}$) for Volume and Line Sources.

Type of Source	Procedure for Obtaining Initial Dimension
Initial Lateral Dimension	
Single Volume Source	S_{yo} = (side length)/4.3
Line Source (Represented by Adjacent Volume Sources)	S_{yo} = (side length)/2.15
Line Source (Represented by Separated Volume Sources)	S_{yo} = (center to center distance)/2.15
Initial Vertical Dimension	
Surface-Based Source (h_e ~ 0)	S_{zo} = (vertical dimension of source)/2.15
Elevated Source (h_e > 0) on or Adjacent to a Building	S_{zo} = (building height)/2.15
Elevated Source (h_e > 0) not on or Adjacent to a Building	S_{zo} = (vertical dimension of source)/4.3

AERMOD/ISCST3/ISC-PRIME

- **Source ID**: An identification name for the source being defined, up to 8 characters in length.
- **X Coordinate**: The x (east-west) coordinate for the source location in meters. This location is the center of the volume source.
- **Y Coordinate**: The y (north-south) coordinate for the source location in meters. This location is the center of the volume source.
- **Base Elevation** [m]: The source base elevation. The model only uses the source base elevation if elevated terrain is being used. The default unit is meters.
- **Release Height above Ground** [m]: The release height above ground surface in meters (center of volume).
- **Emission Rate** [g/s]: The emission rate of the pollutant in grams per second. The same emission rate is used for both concentration and deposition calculations.
- **Length of Side** [m]: The length of the side of the volume source in meters. The volume source cannot be rotated and has the X side equal to the Y side (square).
- **Building Height** (If On or Adjacent to a Building) [m]: If your volume source is elevated and is on or adjacent to a building, then you need to specify the building height. The building height can be used to calculate the Initial Vertical Dimension of the source. Note that if the source is surface-based, then this is not applicable.
- **Initial Lateral Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 3.1 above. This table provides guidance on determining initial dimensions. Units are in meters.
- **Initial Vertical Dimension** [m]: This parameter is calculated by choosing the appropriate condition in Table 3.1 above. This table provides guidance on determining initial dimensions. Units are in meters.

3.7.2 Source Grouping

Source groups enable modeling results for specific groups of one or more sources. The default in AERMOD and ISCST3/ISC-PRIME is the creations of a source group "ALL" that considers all the sources at the same time.

Analysis of individual groups of sources can be performed by using the SRCGROUP option. One example may be assigning each source to a separate source group to determine the maximum concentration generated by each individual source.

3.7.3 Special Considerations

During some air quality studies, modelers may encounter certain source configurations that require special attention. Some examples include horizontal sources or emissions from storage tanks. The following sections outline modeling techniques to account for the special characteristics of such scenarios.

3.7.3.1 Multiple Stacks

When the plumes from multiple closely spaced stacks or flues merge, the plume rise can be enhanced. Briggs[25] has proposed equations to account for this. The reader is referred to that document for further details. Most models do not explicitly account for enhanced plume rise from this cause, and most regulatory agencies do not permit it to be accounted for in regulatory applications of modeling, with one exception. That exception is the case of a single stack with multiple flues/multiple stacks very close together (less than one stack diameter apart). In these cases, the multiple plumes may be treated as a single plume. To do this, a pseudo stack diameter is used in the calculations, such that the total volume flow rate of the stack gases is correctly represented.

3.7.3.2 Horizontal Sources and Rain Caps

This section is intended to provide guidance for modeling a stack with a rain cap that is located on top of a building.

When emissions are released through a stack with a rain cap, the rain cap redirects the vertical release into a horizontal release, as shown in Figure 3.4.

The presence of a rain cap or any obstacle at the top of the stack hinders the momentum of the exiting gas. Therefore, assuming that the gas exit velocity would be the same as the velocity in a stack without an obstacle is an improper assumption. The extent of the effect is a function of the distance from the stack exit to the obstruction and of the dimensions and shape of the obstruction.

On the conservative side, the stack could be modeled as having a non-zero, but negligible exiting velocity, effectively eliminating any momentum rise. Such an approach would result in final plume heights closer to the ground and therefore higher concentrations nearby.

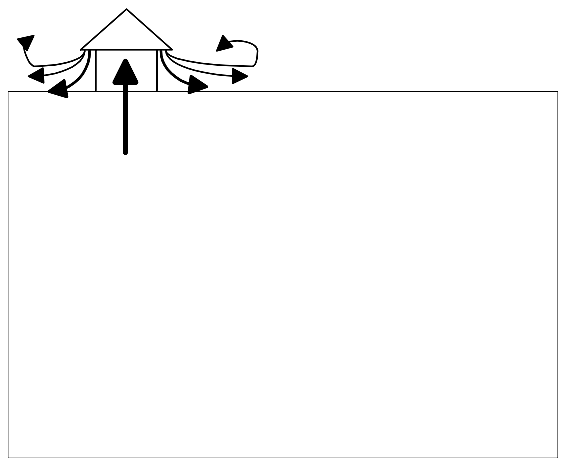

Figure 3.4

Plume buoyancy is not strongly reduced by the occurrence of a rain cap. Therefore if the plume rise is dominated by buoyancy, it is not necessary to adjust the stack conditions. (The air dispersion models determine plume rise by either buoyancy or momentum, whichever is greater.)

The stack conditions should be modified when the plume rise is dominated by momentum and in the presence of a rain cap or a horizontal stack. Sensitivity studies with the SCREEN3 model, on a case-by-case basis, can be used to determine whether plume rise is dominated by buoyancy or momentum. The District should be consulted before applying these procedures.

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[25] Briggs, G.A., 1974. Diffusion Estimation for Small Emissions. In ERL, ARL USAEC Report ATDL-106. U.S. Atomic Energy Commission, Oak Ridge, TN.

- Set exit velocity to 0.001 m/sec
- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter

Stack tip downwash is a function of stack diameter, exit velocity, and wind speed. The maximum stack tip downwash is limited to three times the stack diameter in the ISC3 air dispersion model. In the event of a horizontal stack, stack tip downwash should be turned off and no stack height adjustments should be made.

Note: This approach may not be valid for large (several meter) diameter stacks.

An alternative, more refined, approach could be considered for stack gas temperatures which are slightly above ambient (e.g., ten to twenty degrees Fahrenheit above ambient). In this approach, the buoyancy and the volume of the plume remains constant and the momentum is minimized.

- Turn stack tip downwash off
- Reduce stack height by 3 times the stack diameter ($3D_o$)
- Set the stack diameter (D_b) to a large value (e.g., 10 meters)
- Set the stack velocity to $V_b = V_o\ (D_o/D_b)^2$

Where:

V_o and D_o are the original stack velocity and diameter, and
V_b and D_b are the alternative stack velocity and diameter for constant buoyancy.

This approach is advantageous when $D_b \gg D_o$ and $V_b \ll V_o$ and should only be used with District approval.

Reference: Technical Support Document for Exposure and Stochastic Analysis, Office of Environmental Health Hazard Assessment, September 2000, p. 2-39 and p. 2-40.

3.7.3.3 Modeling Bay Door or Window Openings (Volume Source)

This section is intended to provide guidance for modeling openings such as doors and windows as a volume source. When determining how to model an opening, first determine how the emissions are being released from the opening. If a profile of the emissions (% of substance and heat at different levels) is not provided, then assume that emissions are being released at all levels of the opening, and that the emissions are going out some distance from the opening before they are mixed with the outside air. Thus the release from the opening resembles a volume source where the height is the height of the opening, and the width is the width of the opening, and length is also the width of the opening. Volume source modeling requires the width and length to be equal.

Based on these assumptions, the height of the volume is equal to the height of the opening, the width of the volume is equal to the width of the opening, and the length of the volume is equal to the distance from the opening to the nearest edge of the building, see Figure 3.5.

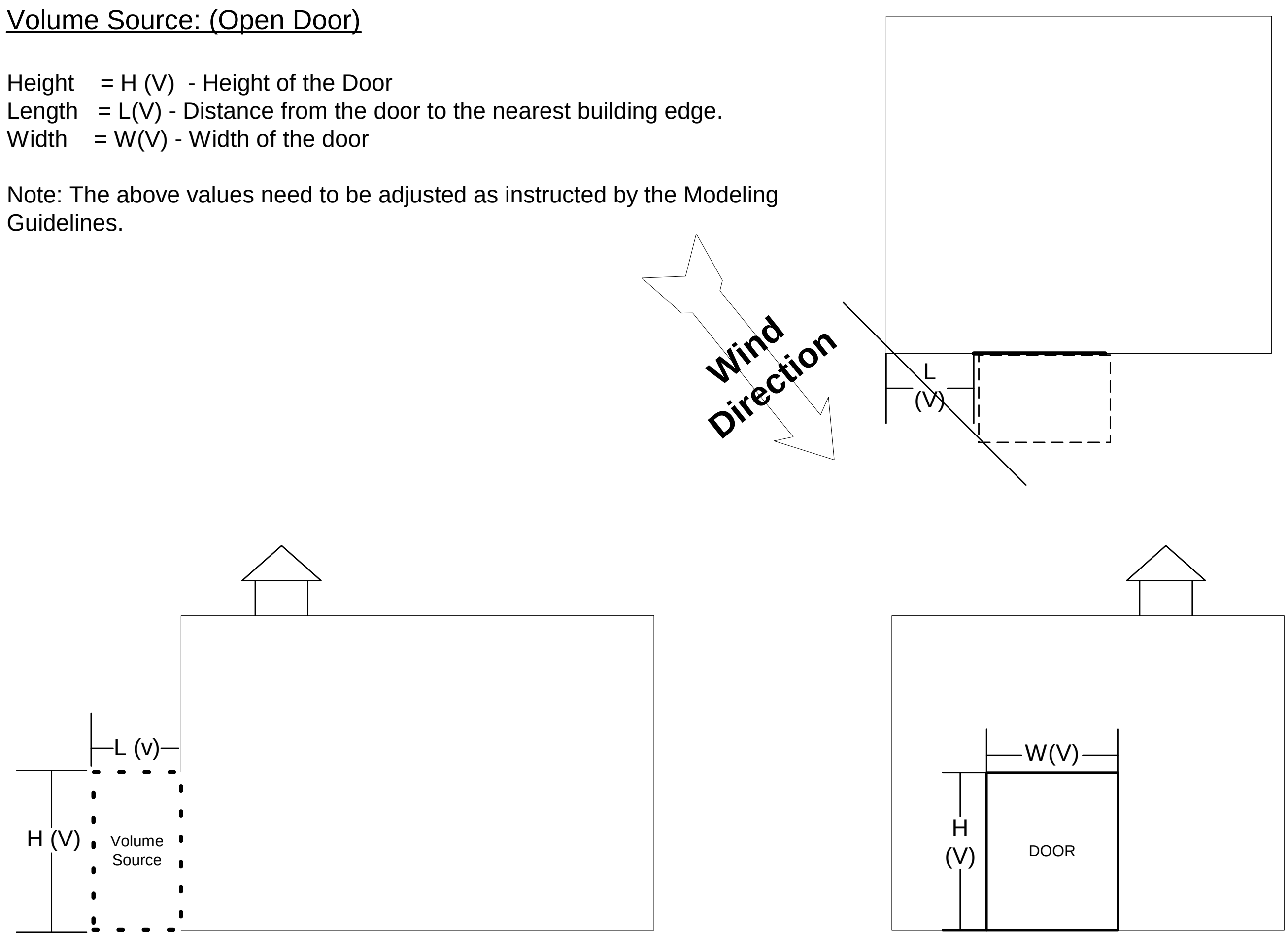

Figure 3.5

3.7.3.4 Liquid Storage Tanks

Storage tanks are generally of two types—fixed roof tanks and floating roof tanks. In the case of fixed roof tanks, most of the pollutant emissions occur from a vent, with some additional contribution from hatches and other fittings. In the case of floating roof tanks, most of the pollutant emissions occur through the seals between the roof and the wall and between the deck and the wall, with some additional emissions from fittings such as ports and hatches.

Approaches for modeling impacts from emissions from various types of storage tanks are outlined below.

Fixed roof tanks:
Model fixed roof tanks as a point (stack) source (representing the vent), which is usually in the center of the tank, and representing the tank itself as a building for downwash calculations.

Floating roof tanks:
Model floating roof tanks as a circle of eight (or more) point sources, representing the tank itself as a building for downwash calculations. Distribute the total emissions equally among the circle of

point sources. Additionally, a floating roof tanks can be modeled as a circle (polygon) area source representing the diameter of the tank with a height of the tank.

All tanks:
There is virtually no plume rise from tanks. Therefore, the stack parameters for the stack gas exit velocity and stack diameter should be set to near zero for the stacks representing the emissions. In addition, stack temperature should be set equal to the ambient temperature. This is done in ISCST3 and AERMOD by inputting a value of 0.0 for the stack gas temperature.

Note that it is very important for the diameter to be at or near zero. With low exit velocities and larger diameters, stack tip downwash will be calculated. Since all downwash effects are being calculated as building downwash, the additional stack tip downwash calculations would be inappropriate. Since the maximum stack tip downwash effect is to lower plume height by three stack diameters, a very small stack diameter effectively eliminates the stack tip downwash.

Table 3.2 - Stack parameter values for modeling tanks

Velocity	Diameter	Temperature
Near zero i.e. 0.001 m/s	Near zero i.e. 0.001m	Ambient – 0.0 sets models to use ambient temperature

3.7.4 Variable Emissions

The ISCST3 and AERMOD models both contain support for variable emission rates. This allows for modeling of source emissions that may fluctuate over time. Emission variations can be characterized across many different periods including hourly, daily, monthly and seasonally. For risk assessments, only the annual average or the maximum hourly emission rates are to be modeled. If a variable emission rate is to be used, the District must be consulted.

3.7.4.1 Wind Erosion

Modeling of emissions from sources susceptible to wind erosion, such as coal piles, can be accomplished using variable emissions.

The ISCST3 and AERMOD models allow for emission rates to be varied by wind speed. This allows for more representative emissions from sources that are susceptible to wind erosion, particularly waste piles that can contribute to particulate emissions. Once a correlation between emissions and wind speed categories is established, the models will then vary the emissions based on the wind conditions in the meteorological data.

3.7.4.2 Non-Continuous Emissions

Sources of emissions at some locations may emit only during certain periods of time. Emissions can be varied within the ISCST3 and AERMOD models by applying factors to different time periods.

For example, for a source that is non-continuous, a factor of 0 is entered for the periods when the source is not operating or is inactive. Model inputs for variable emissions rates can include the following time periods:

- Seasonally
- Monthly
- Hourly
- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, and week

3.7.4.3 Plant Shutdowns and Start-Ups

Plant start-ups and shutdowns can occur due to maintenance, designated vacation periods, or upset conditions. Emissions during shutdown and startup are usually higher than during normal operation. Process upsets or control equipment breakdowns can also increase emissions. Such upsets can result in the release of uncontrolled emissions. The ISC and AERMOD models allow the use of variable emission rates for hours of the day, day of the week, and season of the year. The example below illustrates the use of this feature to model emissions that vary by the time of the day.

Example:
Assume that a gas turbine operates 14 hours per day (1 startup, 1 shutdown, and 12 hours of normal operation

Given:
Emission Rate = 1 g/s (emissions rate during normal operation)
Operation Schedule = 6 AM – 8PM
Startup/Shutdown Emissions are twice that of normal operating emissions

The model will adjust the emissions rate using the data found in the table below:

Calculation:
Modeled Emissions Rate * Emission Rate Adjustment Factor

Emissions Rate for 1 AM – 6 AM = 1 g/s * 0 = 0 g/s
Emissions Rate for 6 AM – 7 AM = 1 g/s * 2 = 2 g/s
Emissions Rate for 7 AM – 7 PM = 1 g/s * 1 = 1 g/s
Emissions Rate for 7 PM – 8 PM = 1 g/s * 2 = 2 g/s

Non-Continuous Emissions (Hours of Day):

Morning Hours		Afternoon Hours	
Hour of the Day	**Emissions Rate Adjustment Factor**	**Hour of the Day**	**Emissions Rate Adjustment Factor**
1:00 am	0	1:00 pm	1
2:00 am	0	2:00 pm	1
3:00 am	0	3:00 pm	1
4:00 am	0	4:00 pm	1
5:00 am	0	5:00 pm	1
6:00 am	2	6:00 pm	1
7:00 am	1	7:00 pm	2
8:00 am	1	8:00 pm	0
9:00 am	1	9:00 pm	0
10:00 am	1	10:00 pm	0
11:00 am	1	11:00 pm	0
Noon	1	Midnight	0

3.7.4.4 Seasonal Variations

Industrial processes often fluctuate depending on supply and demand requirements. This affects some sectors seasonally, particularly facilities involved in food processing. For example, soup production makes use of agricultural produce which is at its highest in the late summer. Production schedules for soup production typically ramp up resulting in different emissions during the late summer and early fall than at mid to late winter.

These emission differences can be accounted for by the application of variable emission factors, with control over the following time periods:

- By Season and hour-of-day
- By Season, hour-of-day, and day-of-week
- By Season, hour, week

3.8 Building Impacts

Buildings and other structures near a relatively short stack can have a substantial effect on plume transport and dispersion, and on the resulting ground-level concentrations that are observed. . There has long been a "rule of thumb" that a stack should be at least 2.5 times the height of adjacent buildings. Beyond that, much of what is known of the effects of buildings on plume transport and diffusion has been obtained from wind tunnel studies and field studies.

When the airflow meets a building (or other obstruction), it is forced up and over the building. On the lee side of the building, the flow separates, leaving a closed circulation containing lower wind speeds. Farther downwind, the air flows downward again. In addition, there is more shear and, as a result, more turbulence. This is the turbulent wake zone (see Figure 3.6).

If a plume gets caught in the cavity, very high concentrations can result. If the plume escapes the cavity, but remains in the turbulent wake, it may be carried downward and dispersed more rapidly by the turbulence. This can result in either higher or lower concentrations than would occur without the building, depending on whether the reduced height or increased turbulent diffusion has the greater effect.

The height to which the turbulent wake has a significant effect on the plume is generally considered to be about the building height plus 1.5 times the lesser of the building height or width. This results in a height of 2.5 building heights for cubic or squat buildings, and less for tall, slender buildings. Since it is considered good engineering practice to build stacks taller than adjacent buildings by this amount, this height came to be called "good engineering practice" (GEP) stack height.

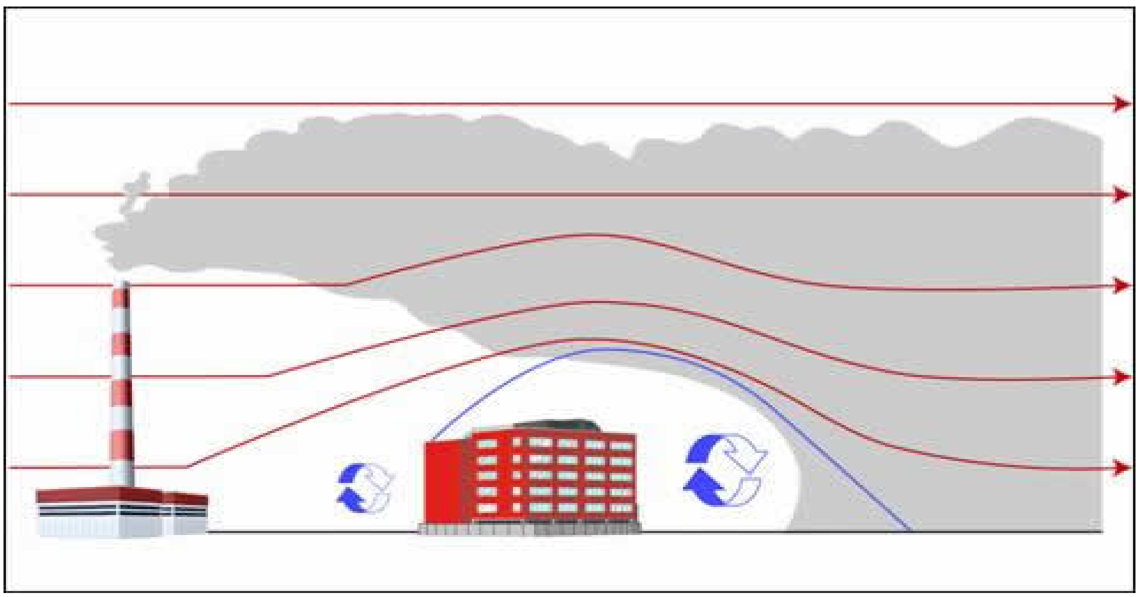

Figure 3.6 - The building downwash concept where the presence of buildings forms localized turbulent zones that can readily force pollutants down to ground level.

3.8.1 Good Engineering Practice (GEP) Stack Heights and Structure Influence Zones

The U.S. EPA[26] states that "If stacks for new or existing major sources are found to be less than the height defined by the EPA's refined formula for determining GEP height, then air quality impacts associated with cavity or wake effects due to the nearby building structures should be determined."

The U.S. EPA's refined formula for determining GEP stack height is:

GEP Stack Height = H + 1.5L

[26] U.S. Environmental Protection Agency, 1990. Stack Heights, Section 123, Clean Air Act, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

where,

GEP = Good Engineering Practice

H = Building/Tier Height measured from ground to the highest point

L = Lesser of the Building Height (PB) or Projected Building Width (PBW)

Building downwash for point sources that are within the Area of Influence of a building should be considered. For U.S. EPA regulatory applications, a building is considered sufficiently close to a stack to cause wake effects when the distance between the stack and the nearest part of the building is less than or equal to five (5) times the lesser of the building height or the projected width of the building.

$Distance_{stack\text{-}bldg} <= 5L$

For point sources within the Area of Influence, building downwash information (direction-specific building heights and widths) should be included in your modeling project. Using BPIP-PRIME, you can compute these direction-specific building heights and widths.

Structure Influence Zone (SIZ): For downwash analyses with direction-specific building dimensions, wake effects are assumed to occur if the stack is within a rectangle composed of two lines perpendicular to the wind direction, one at 5L downwind of the building and the other at 2L upwind of the building, and by two lines parallel to the wind direction, each at 0.5L away from each side of the building, as shown below. L is the lesser of the height or projected width. This rectangular area has been termed a Structure Influence Zone (SIZ). Any stack within the SIZ for any wind direction is potentially affected by GEP wake effects for some wind direction, or range of wind directions, see Figure 3.7 and Figure 3.8.

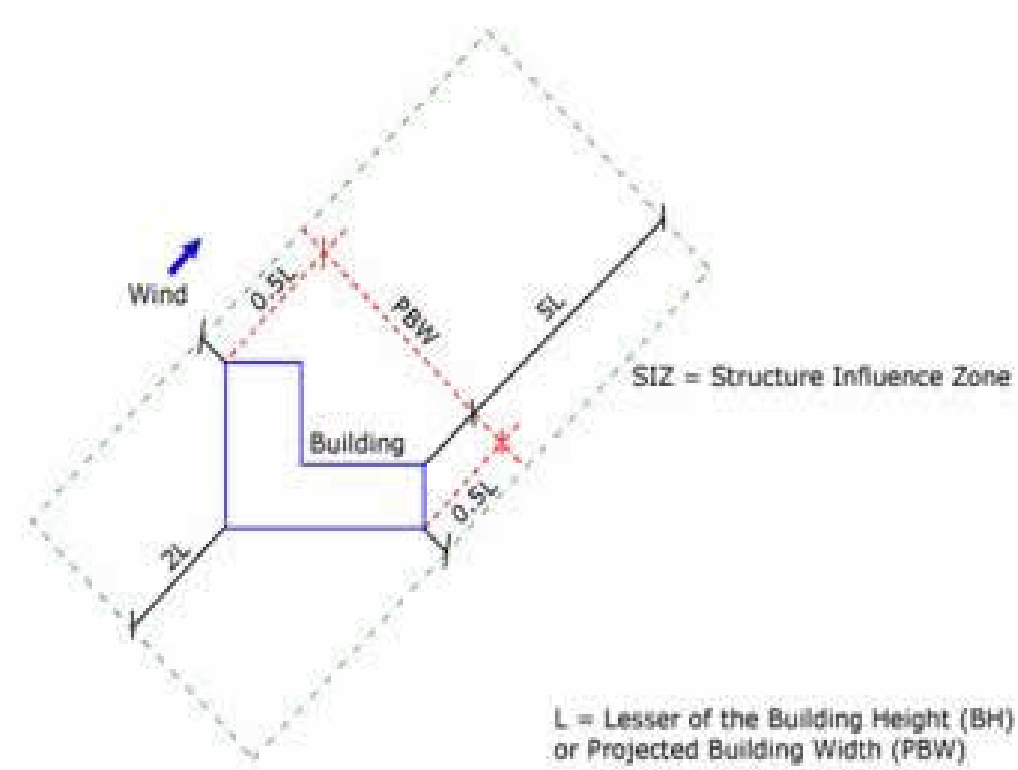

Figure 3.7 - GEP 5L and Structure Influence Zone (SIZ) Areas of Influence

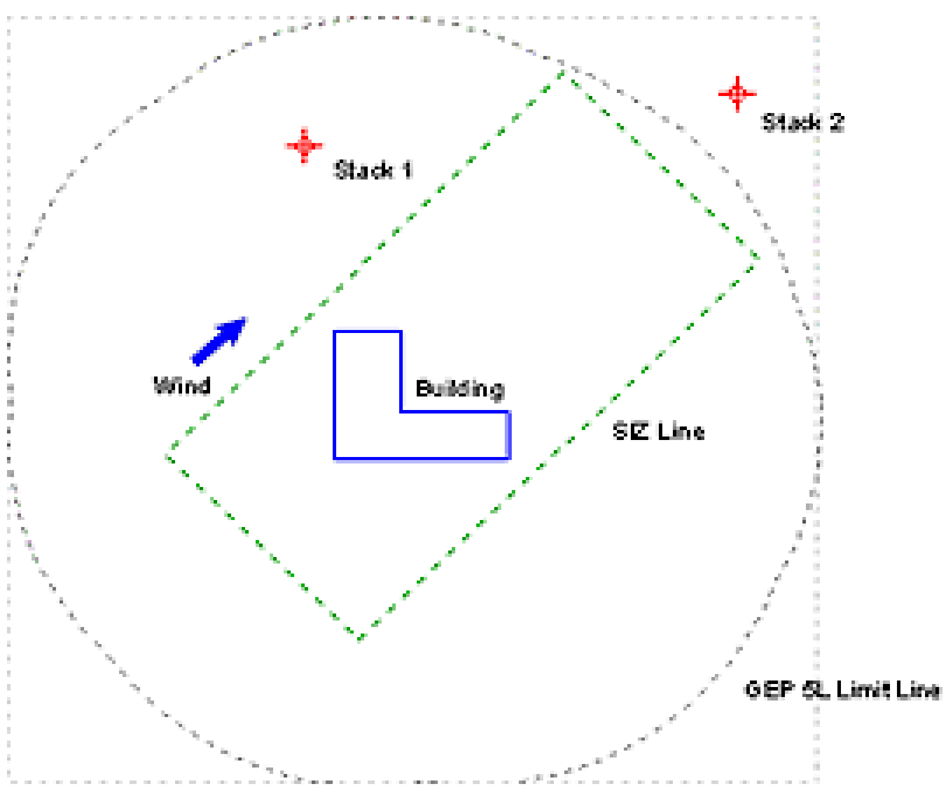

Figure 3.8 -GEP 360° 5L and Structure Influence Zone (SIZ) Areas of Influence

3.8.2 Defining Buildings

The recommended screening and refined models all allow for the consideration of building downwash. SCREEN3 considers the effects of a single building while AERMOD and ISCST3/ISC-PRIME can consider the effects of complicated sites consisting of up to hundreds of buildings. This results in different approaches to defining buildings as outlined below.

3.8.2.1 SCREEN3 Building Definition

Defining buildings in SCREEN3 is straightforward, as only one building requires definition. The following input data is needed to consider downwash in SCREEN3:

- Building Height: The physical height of the building structure in meters.
- Minimum Horizontal Building Dimension: The minimum horizontal building dimension in meters.
- Maximum Horizontal Building Dimension: The maximum horizontal building dimension in meters.

For Flare releases, SCREEN assumes the following:

- an effective stack gas exit velocity (V_s) of 20 m/s,
- an effective stack gas exit temperature (T_s) of 1,273 K, and
- an effective stack diameter based on the heat release rate.

Since building downwash estimates depend on transitional momentum plume rise and transitional buoyant plume rise calculations, the selection of effective stack parameters could influence the estimates. Therefore, building downwash estimates for flare releases should be used with extra caution[27].

If using Automated Distances or Discrete Distances option, wake effects are included in any calculations made. Cavity calculations are made for two building orientations, first with the minimum horizontal building dimension along wind, and second with the maximum horizontal dimension along wind. The cavity calculations are summarized at the end of the distance-dependent calculations (see SCREEN3 User's Guide[32] Section 3.6 for more details).

3.8.2.2 AERMOD and ISC-PRIME Building Definition

The inclusion of the PRIME (Plume Rise Model Enhancements) algorithm[28] to compute building downwash has produced more accurate results in air dispersion models. Unlike the earlier algorithms used in ISC3, the PRIME algorithm:

[27] U.S. Environmental Protection Agency, 1995. SCREEN3 Model User's Guide. EPA-454/B-95-004. Office of Air Quality Planning and Standards, Research Triangle Park, NC.
[28] Schulman, L.L., D.G. Strimaitis and J.S. Scire, 2000: Development and evaluation of the PRIME plume rise and building downwash model. Journal of the Air & Waste Management Association, 50:378-390.

- accounts for the location of the stack relative to the building;
- accounts for the deflection of streamlines up over the building and down the other side;
- accounts for the effects of the wind profile at the plume location for calculating plume rise;
- accounts for pollutants captured in the recirculation cavity to be transported to the far wake downwind (this is ignored in the earlier algorithms); and
- avoids discontinuities in the treatment of different stack heights, which were a problem in the earlier algorithms.

Refined models allow for the consideration of downwash effects from multiple buildings. AERMOD and ISCST3/ISC-PRIME require building downwash analysis to first be performed using BPIP-PRIME[28]. The results from BPIP-PRIME can then be incorporated into the modeling studies for consideration of downwash effects.

The U.S. EPA Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) was designed to incorporate enhanced downwash analysis data for use with the U.S. EPA ISC-PRIME and current AERMOD models. Similar in operation to the U.S. EPA BPIP model, BPIP-PRIME uses the same input data requiring no modifications of existing BPIP projects. The following information is required to perform building downwash analysis within BPIP:

- X and Y location for all stacks and building corners.
- Height for all stacks and buildings (meters). For building with more than one height or roofline, identify each height (tier).
- Base elevations for all stacks and buildings.

The BPIP User's Guide[29] provides details on how to input building and stack data to the program.

The BPIP model is divided into two parts.

- Part One: Based on the GEP technical support document[30], this part is designed to determine whether or not a stack is subject to wake effects from a structure or structures. Values are calculated for GEP stack height and GEP related building heights (BH) and projected building widths (PBW). Indication is given to which stacks are being affected by which structure wake effects.
- Part Two: Calculates building downwash BH and PBW values based on references by Tickvart[31,32] and Lee[33]. These can be different from those calculated in Part One. The calculations are performed only if a stack is being influenced by structure wake effects.

In addition to the standard variables reported in the output of BPIP, BPIP-PRIME adds the following:

- BUILDLEN: Projected length of the building along the flow.

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[29] U.S. Environmental Protection Agency, 1995. User's Guide to the Building Profile Input Program, EPA-454/R-93-038, Office of Air Quality Planning and Standards, Research Triangle Park, N.C.

[30] U.S. Environmental Protection Agency, 1985. Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) – Revised EPA-450/4-80-023R, U.S. Environmental Protection Agency, Research Triangle Park, NC.

[31] Tickvart, J. A., May 11, 1988. Stack-Structure Relationships, Memorandum to Richard L. Daye, U.S. EPA.

[32] Tickvart, J. A., June 28, 1989. Clarification of Stack-Structure Relationships, Memorandum to Regional Modeling Contacts, Regions I-X, U.S. EPA.

[33] Lee, R. F., July 1, 1993. Stack-Structure Relationships – Further clarification of our memoranda dated May 11, 1988 and June 28, 1989, Memorandum to Richard L. Daye, U.S. EPA.

- XBADJ: Along-flow distance from the stack to the center of the upwind face of the projected building.
- YBADJ: Across-flow distance from the stack to the center of the upwind face of the projected building.

For a more detailed technical description of the EPA BPIP-PRIME model and how it relates to the EPA ISC-PRIME model see the Addendum to ISC3 User's Guide[34].

3.9 Multiple Pollutants

3.9.1 Modeling Multiple Pollutants from Multiple Sources

Industrial processes often emit multiple pollutants through one or several emission sources. The U.S. EPA models are not equipped to automatically perform modeling of different pollutants that may share the same emission source but have unique emission rates.

Traditional approaches to this scenario resulted in modelers performing separate model runs for each specific pollutant type, even though all other model site parameters remain the same. For projects consisting of many pollutants, this approach results in the modeler needing not only to be extremely organized but also requires high levels of computer resources as the project would need to be run separately for each pollutant scenario.

An alternative approach is applying unitized emission rate and summation concepts, which drastically reduce the computational time for large multiple pollutant projects.

3.9.1.1 Standard Approaches to Modeling Multiple Toxic Pollutants from Multiple Sources

For industrial processes that emit multiple pollutants through one or several emission sources, the following approach should be followed.

- Dispersion modeling should be conducted as outlined in this guidance document using a unit (normalized) emissions rate of 1 g/s, or $1/g/s/m^2$ for area sources.
- All chemical analysis / risk calculations should be processed through the CARB HARP program http://www.arb.ca.gov/toxics/harp/harp.htm.
- Exceptions (Must be given prior approval by the district):
  - Analysis of multiple pollutants that only affect one acute toxicological endpoint or the same endpoints.
  - Analyses of multiple pollutants that only affect one chronic toxicological endpoint or the same endpoint and do not have a chronic oral value.
  - Analysis of multiple pollutants that are not multi-pathway (only inhalation)
    - One dispersion modeling run for

[34] Schulman, et al., 1997. Addendum - User's Guide for the Industrial Source Complex (ISC3) Dispersion Models, Volume 1. Office of Air Quality Planning and Standards, Research Triangle Park, NC.

- Acute Hazard Index,
- Chronic Hazard Index, and
- Cancer Risk.

3.9.2 Unitized (Normalized) Emission Rate and Summation Concepts

It is a well-known fact that air dispersion modeling is a non-linear process. The modeled site may have random meteorological variations, the dispersion process is non-linear, and the terrain elevations at the site may assume unlimited shapes. However, once the calculations to a receptor in space are complete, all chemical concentration levels vary linearly with their source release rate. Figure 3.9 helps visualize this concept, by describing an emission rate of 1 g/s.

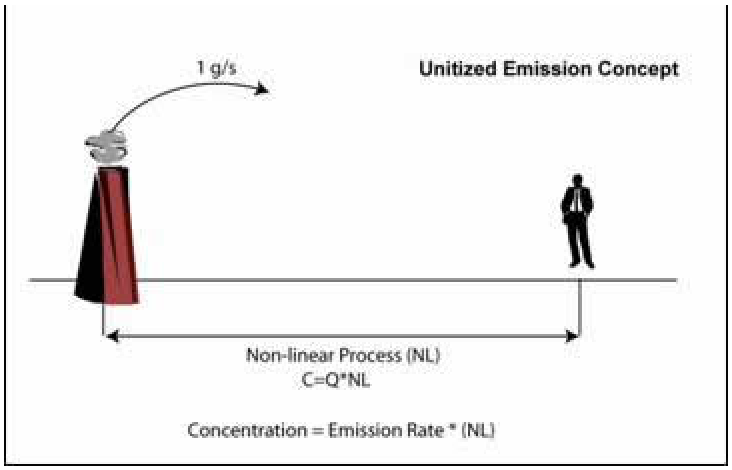


Figure 3.9 - Unitized Emission Rate Concept (1 g/s)

The Unitized Emission Rate Concept only applies to single sources. For assessments with multiple sources the authors recommend that each source be modeled independently, using unitized emission rate (1 g/s). The concentration at the receptor can then be multiplied by the actual chemical emission rate, and the final result from all the sources will be superimposed. This is called the Summation Concept, where the concentration and deposition fluxes at a receptor are the linear addition of the resulting values from each source. Figure 3.10 depicts the Summation concept.

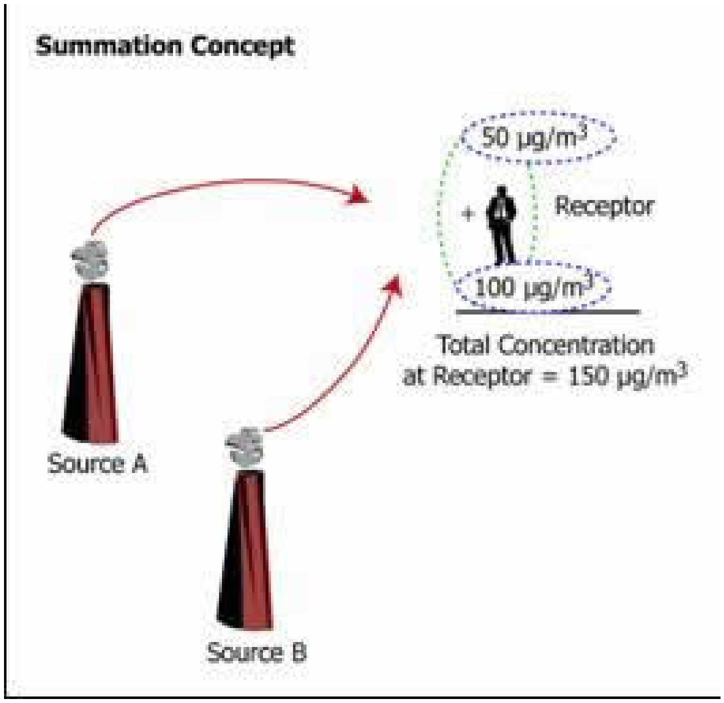


Figure 3.10 - The Summation Concept for two sources

A post-processor is needed to effectively process model results that have been performed using unitized emission rate and summation concepts. Final output will provide results for pollutant specific scenarios from multiple sources.

3.10 Modeling Roads

There are a number of dispersion models that can be used to predict concentrations from roadway emissions. Some models such as CAL3QHCR were developed solely for use in modeling roadway emissions. They use a line source algorithm. CAL3QHCR is a preferred/recommended U.S. Environmental Protection Agency (EPA) model for roadway modeling that uses local meteorology. EPA also recommends the CALINE3 model. But, CALINE3 does not use local meteorology. It is included in CAL3QHCR. The Industrial Source Complex – Short-Term (ISCST3) and the AERMOD models can be used to model roadways as a line of volume sources. AERMOD is the recommended EPA model. However, some Districts still use ISCST3 because they do not yet have the meteorological data needed for AERMOD. The methodology for modeling using AERMOD is the same as that for using ISCST3. The input data is almost identical because AERMOD was designed to use input similar to that used by ISCST3 and to provide similar outputs. The major differences between the inputs to the two models are the meteorological data sets. During the preparation of this guideline, an analysis was conducted to compare concentrations predicted by all three models for a specific example. This analysis showed that all three models provided similar concentration estimates, and that any of the three models could be used effectively to predict pollutant concentrations and the resulting risk from roadway emissions.

In the discussion below, use of CAL3QHCR is described first. That discussion includes a description of data sources to estimate emissions. The same approach can be used to develop emissions estimates for ISCST3/AERMOD.

3.10.1 Modeling Roads using CAL3QHCR

3.10.1.1 Introduction

This step by step guidance explains how to use the CAL3QHCR line source model to carry out diesel particulate matter air dispersion modeling, and how to calculate potential cancer risk. Nine potential receptors are assumed to lie directly south of an east-west free-flow freeway with a peak hour traffic count of 11,900 vehicles. The freeway is assumed to be 120 feet wide, with an additional 10 feet on each side to account for the wake of moving vehicles[35], making for a total link width of 140 feet.

This example represents one specific scenario. For guidance on other CAL3QHCR modeling scenarios not contained herein, contact your local air district or consult the User's Guide to CAL3QHC, Version 2.0 [36].

3.10.1.2 Data Sources

This example scenario relies on basic information needed to complete the site specific HRA. Such information includes:

- meteorological data,
- traffic data (from Caltrans), later developed into hourly data,
- vehicle emissions (derived from EMFAC),
- location of the nearest sensitive receptor to the edge of the travel lane, in addition to the generic receptor locations, if required (for example, at 10, 25, 50, 100, 200, 300, 400 and 500 feet) in X-Y coordinates, and
- roadway orientation in terms of its X-Y coordinates (arbitrary origin / 0,0), including length and width.

The above information, including additional information required by the model, is further discussed in the ensuing sections of this document.

3.10.1.3 Finding the Peak Hour Traffic Count

The peak hour traffic count nearest to the proposed receptors is used to develop the hourly traffic count information for input into CAL3QHCR. The peak hour traffic count should be found on Caltrans's website at http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/index.htm. Select back peak hour for projects south or west of the nearest milepost location. For projects north or east of the nearest milepost location, select ahead peak hour.

---

[35] The mixing zone is an area where dispersion results are considered to be inaccurate.
[36] User's Guide to CAL3QHC Version 2.0, EPA-454/R-92-006 (Revised, with CAL3QHCR addendum), September 1995.

For the scenario considered herein, the Caltrans's data indicates a peak hour traffic count of 11,900 vehicles.

Running EMFAC to Produce Hourly PM10 Emissions and Data on Vehicle Miles Traveled

The most current version of EMFAC should be run to determine preliminary vehicle miles traveled (VMT) and emissions data. The VMT data will be used to develop the hourly traffic count information required by CAL3QHCR, and the PM10 exhaust emissions data will be used to determine the hourly PM10 emissions rates for input into CAL3QHCR.

The EMFAC run should be based on the following parameters:

- Year: first year of project build out,
- Season: annual,
- Burden: standard, and
- Output Frequency: hourly.

The following data from the EMFAC output file will be used:

- VMT/1000 for each hour,
- PM10 emissions for each hour.

Figure 3.11 is a screen shot of the first page of the EMFAC output file. The circled hourly data is the data that will be used.

This methodology is a **<u>screening method</u>** to determine the cancer risk from diesel exhaust assuming that all vehicles traveling the roadway segment are diesel vehicles.

A refinement of the emission calculations can be made by using data on percentages of truck traffic from Caltrans and assuming that all trucks are diesel. If better data is not available, 10% is sometimes assumed as the diesel truck fraction of vehicles.

To refine the emissions calculations further to account for diesel emissions from diesel trucks, and to account for the emissions of the highest priority toxic substances (1,3 butadiene, acrolein, acetaldehyde, formaldehyde, and benzene) from all vehicles, the procedure in Appendix B should be followed.

Contact the local district to determine which method should be used to estimate diesel truck travel.

Figure 3.11: Example Scenario EMFAC Output, Page 1

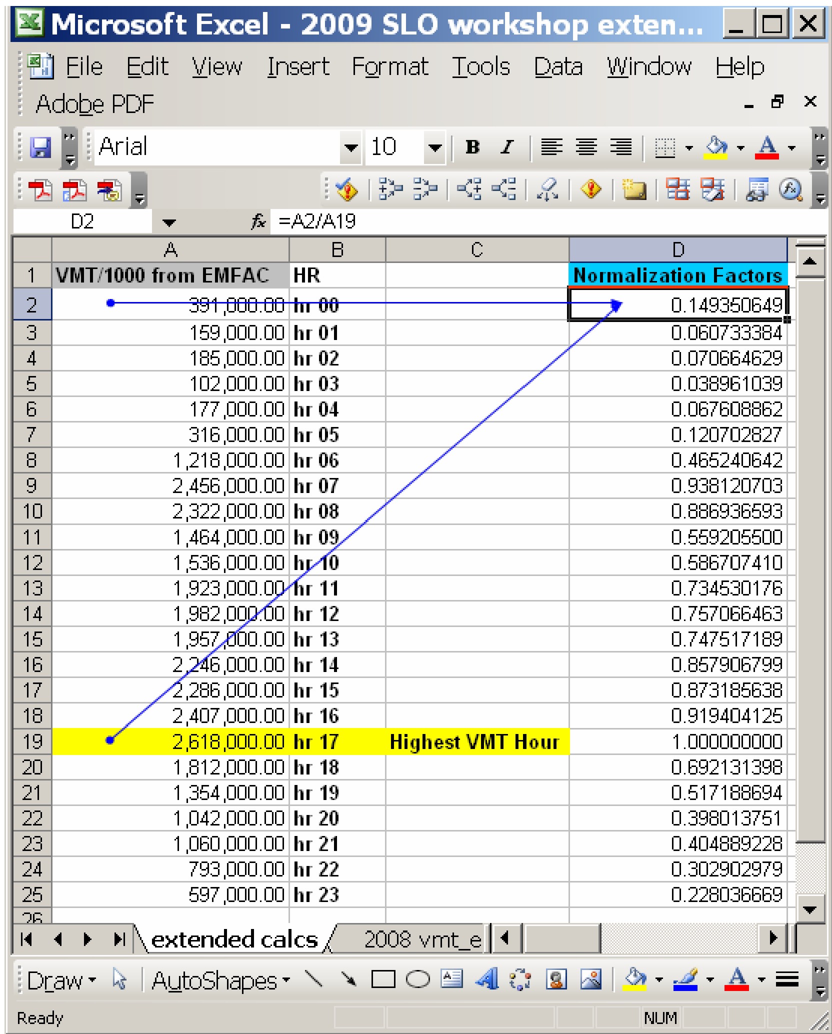
```
Version   : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/06 15:08:23
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season    : Annual
Area      : Sacramento Metropolitan AQMD Avereg
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 31 Sacramento (SV)
Emissions: Tons Per Hr00
```

	Light Duty Passenger Cars				Light Duty Trucks				Medium Duty Trucks				Heavy Duty Trucks: Gasoline Trucks			Diesel Trucks	Total HD Trucks	Urban Buses	Motor-cycles	All Vehicles
	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Diesel	Total	Non-cat	Cat	Total					
Vehicles	7632.	483025.	1673.	492331.	5806.	307893.	8213.	321912.	1391.	117094.	9051.	127537.	1330.	11346.	12677.	18201.	30878.	371.	34494.	1007520.
VMT/1000	1.	160.	0.	162.	1.	109.	2.	112.	0.	41.	21.	63.	0.	1.	1.	50.	51.	0.	3.	391.
Trips	256.	25555.	78.	25889.	198.	16328.	423.	16950.	76.	8729.	3082.	11887.	326.	1629.	1954.	965.	2920.	16.	580.	[illegible]
Total Organic Gas Emissions																				
Run Exh	0.01	0.01	0.00	0.02	0.01	0.01	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.03	0.04	0.00	0.01	0.10
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.00	0.02	0.00	0.00	0.07
Total Ex	0.01	0.03	0.00	0.04	0.01	0.02	0.00	0.03	0.00	0.02	0.00	0.03	0.01	0.01	0.02	0.04	0.06	0.00	0.01	0.17
Diurnal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hot Soak	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Running	0.01	0.02	0.00	0.02	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Resting	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Total	0.02	0.06	0.00	0.08	0.01	0.05	0.00	0.06	0.00	0.03	0.00	0.04	0.01	0.01	0.02	0.04	0.06	0.00	0.02	0.26
Carbon Monoxide Emissions																				
Run Exh	0.10	0.36	0.00	0.45	0.08	0.31	0.00	0.39	0.05	0.14	0.02	0.20	0.01	0.01	0.03	0.15	0.18	0.00	0.14	1.37
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.01
Start Ex	0.01	0.21	0.00	0.22	0.01	0.16	0.00	0.17	0.00	0.18	0.00	0.18	0.06	0.19	0.25	0.00	0.25	0.00	0.01	0.82
Total Ex	0.10	0.57	0.00	0.67	0.09	0.47	0.00	0.56	0.05	0.31	0.02	0.38	0.07	0.20	0.28	0.16	0.44	0.00	0.15	2.21
Oxides of Nitrogen Emissions																				
Run Exh	0.01	0.04	0.00	0.05	0.00	0.05	0.00	0.06	0.00	0.03	0.11	0.14	0.00	0.01	0.01	0.73	0.74	0.01	0.00	1.00
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.02
Start Ex	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.06
Total Ex	0.01	0.05	0.00	0.06	0.01	0.06	0.00	0.07	0.00	0.05	0.11	0.16	0.00	0.02	0.02	0.76	0.77	0.01	0.00	1.08
Carbon Dioxide Emissions (000)																				
Run Exh	0.00	0.06	0.00	0.06	0.00	0.05	0.00	0.05	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.25
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total Ex	0.00	0.06	0.00	0.06	0.00	0.05	0.00	0.05	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.09	0.09	0.00	0.00	0.25
PM10 Emissions																				
Run Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.03
Idle Exh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Start Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Ex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.03
TireWear	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BrakeWr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Total	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.04
Lead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fuel Consumption (000 gallons)																				
Gasoline	0.08	6.49	0.00	6.57	0.07	5.48	0.00	5.55	0.03	2.91	0.00	2.94	0.03	0.13	0.16	0.00	0.16	0.02	0.07	15.32
Diesel	0.00	0.00	0.01	0.01	0.00	0.00	0.08	0.08	0.00	0.00	1.11	1.11	0.00	0.00	0.00	8.26	8.26	0.07	0.00	9.53

```
Title     : 2009 info
Version   : Emfac2007 V2.3 Nov 1 2006
Run Date : 2008/02/06 15:08:23
Scen Year: 2009 -- All model years in the range 1965 to 2009 selected
Season    : Annual
Area      : Sacramento Metropolitan AQMD Averag
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 31 Sacramento (SV)
Emissions: Tons Per Hr01
```

3.10.1.4 Preparing the Hourly Traffic Count Data

To develop hourly traffic count values needed by CAL3QHCR, first find the highest hourly Vehicle Miles Traveled (VMT) count reported by EMFAC. Figure 3.12 shows an example. In this example, the highest hourly VMT count is 2,618,000 miles, which falls on Hour 17, 5:00 pm. Next, divide each hourly VMT value from EMFAC by the highest hourly VMT count (2,618,000 miles). Each result is known as a normalization factor.



	A	B	C	D
1	VMT/1000 from EMFAC	HR		Normalization Factors
2	391,000.00	hr 00		0.149350649
3	159,000.00	hr 01		0.060733384
4	185,000.00	hr 02		0.070664629
5	102,000.00	hr 03		0.038961039
6	177,000.00	hr 04		0.067608862
7	316,000.00	hr 05		0.120702827
8	1,218,000.00	hr 06		0.465240642
9	2,456,000.00	hr 07		0.938120703
10	2,322,000.00	hr 08		0.886936593
11	1,464,000.00	hr 09		0.559205500
12	1,536,000.00	hr 10		0.586707410
13	1,923,000.00	hr 11		0.734530176
14	1,982,000.00	hr 12		0.757066463
15	1,957,000.00	hr 13		0.747517189
16	2,246,000.00	hr 14		0.857906799
17	2,286,000.00	hr 15		0.873185638
18	2,407,000.00	hr 16		0.919404125
19	2,618,000.00	hr 17	Highest VMT Hour	1.000000000
20	1,812,000.00	hr 18		0.692131398
21	1,354,000.00	hr 19		0.517188694
22	1,042,000.00	hr 20		0.398013751
23	1,060,000.00	hr 21		0.404889228
24	793,000.00	hr 22		0.302902979
25	597,000.00	hr 23		0.228036669

Figure 3.12: Example Scenario Development of Normalization Factors

Next multiply each normalization factor times the project's peak hour traffic count provided in this example by Caltrans (11,900 vehicles/hour during hour 17, 5:00 pm), Table 3.3. The results are normalized hourly traffic volumes for input into CAL3QHCR.

Time of day	Traffic Count (vehicles/hour)
Hr 00	1777
Hr 01	723
Hr 02	841
Hr 03	464
Hr 04	805
Hr 05	1436
Hr 06	5536
Hr 07	11164
Hr 08	10555
Hr 09	6655
Hr 10	6982
Hr 11	8741
Hr 12	9009
Hr 13	8895
Hr 14	10209
Hr 15	10391
Hr 16	10941
Hr 17	**11900**
Hr 18	8236
Hr 19	6155
Hr 20	4736
Hr 21	4818
Hr 22	3605
Hr 23	2714

Table 3. 3: Example Scenario Normalized Traffic Counts

3.10.1.5 Preparing the Hourly Emissions Data

PM10 emissions data is reported by EMFAC in tons/hour and needs to be converted to grams/hour. The grams/hour values then need to be divided by the overall VMT per hour for each hour (as reported by EMFAC), to obtain grams per vehicle mile needed for input into CAL3QHCR.

3.10.1.6 Defining the Calculational Domain for the Input File

The CAL3QHCR input file requires data that defines the calculational domain. The X-Y coordinates at the beginning and at the end of the roadway section need to be defined. These have an arbitrary origin, with the y axis aligned with north.

Additionally, the width (mixing zone) of the roadway needs to be defined. Always allow for an additional 10 feet added to the edge of nearest travel lane to the receptors to account for the wake of moving vehicles.

The minimum roadway length is 10,000 feet.

The elevation of the roadway compared to the surrounding area needs to be specified. For roadways at grade the height is 0; for elevated roadways the relative height is positive; and for depressed roadways the relative height is negative.

The z-coordinate (receptor breathing height) also needs to be defined. The default recommendation is 1.5 meters, or 6 feet.

In this scenario, the freeway is 120 feet wide, and after accounting for the wake, the total link width becomes 140 feet.

The length of the roadway modeled is 10,000 feet, or 5,000 feet on each side from the center point.

The roadway is at grade.

A receptor has been placed at the edge of the roadway to define the roadway dimensions; however the dispersion results for this receptor should be discarded as they are not accurate at roadway edges. See Figure 3.13 below.

Other parameters required by the model need to be defined. Table 3.4 below discusses recommended and/or default parameters. Any changes to the default recommended values should be thoroughly explained.

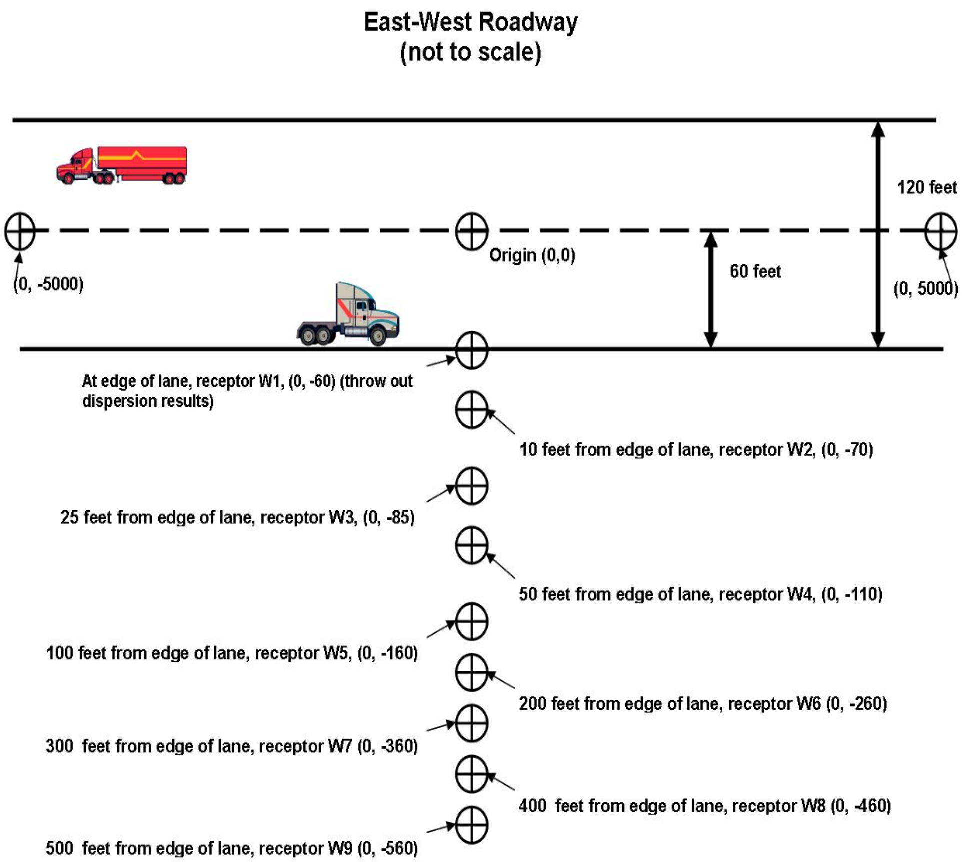


Figure 3.13: Example Scenario East-West Roadway and Receptors Illustration

Table 3.4: Other Recommended Parameters for Input into CAL3QHCR

Parameter	Default	
Calculation averaging time (min)	60	
Surface roughness (cm, from 3 to 400). For mixed uses and others not listed here, the modeler should make a reasonable assumption.	single family	108
	offices	170
	apartments	370
Settling velocity (cm/s)	0	
Deposition velocity (cm/s)	0	
Site setting (U=urban, R=rural)	U	
Form of traffic volume, emission rate data (1=one hour's data, 2=one week of hourly data)	2	
Pollutant (P for PM10 to give output in µg/m^3)	P	
Hourly ambient background concentration (µg/m^3)	0	
Roadway height indicator (AG=at grade, FL=elevated and filled, BR=bridge, DP=depressed)	AG	
Roadway height (ft, 0 if AG, relative height if FL, BR, or DP)	0	

3.10.1.7 Preparing the CAL3QHCR Files

3.10.2.7.1Downloading CAL3QHCR

Download the CAL3QHCR model from EPA's Preferred/Recommended Dispersion Models website at www.epa.gov/scram001/dispersion_prefrec.htm. There are five files needed to run the program:

- input file (.inp),
- batch file (.bat),
- control file (.ctl),
- meteorological data file (.asc), and
- executable file (.exe).

Decide on a name for the run. The name of the example scenario run is "2009south11900k".

Note that in setting up your run, you will be editing over data already present in the files.

Prepare the Batch File (.bat).
The batch file is the DOS file batch command.

Right click on the file to open it for editing. (Note that opening or double clicking on the file will cause the program to run. If this happens, simply delete the files the program creates and start again.) Once the file is open, type in the name of your run after the word "Copy". Save the file with the name of the run. See Figure 3.14 below for the example scenario batch file.

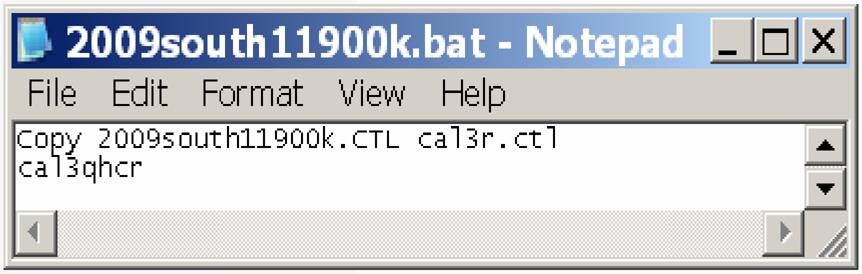


Figure 3.14: Example Scenario Batch File

3.10.1.7.2Prepare the Control File (.ctl)

CAL3QHCR looks to the control file to find the file names that are read into the program and outputted by the program.

Type the name of your run in front of each file extension, except the .ASC file, where you will type in the meteorological data file name. Save the control file with the name of your run. See Figure 3.15 below for the example scenario control file.

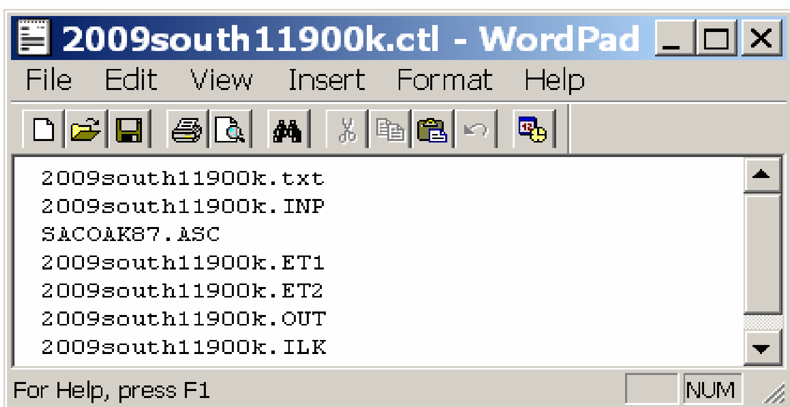


Figure 3.15: Example Scenario Control File

3.10.1.7.3Meteorological File (.asc)

The meteorological file should be in the .asc format. Contact your local air district for the recommended meteorological file. This file will not be edited.

3.10.1.7.4Executable File (.exe)

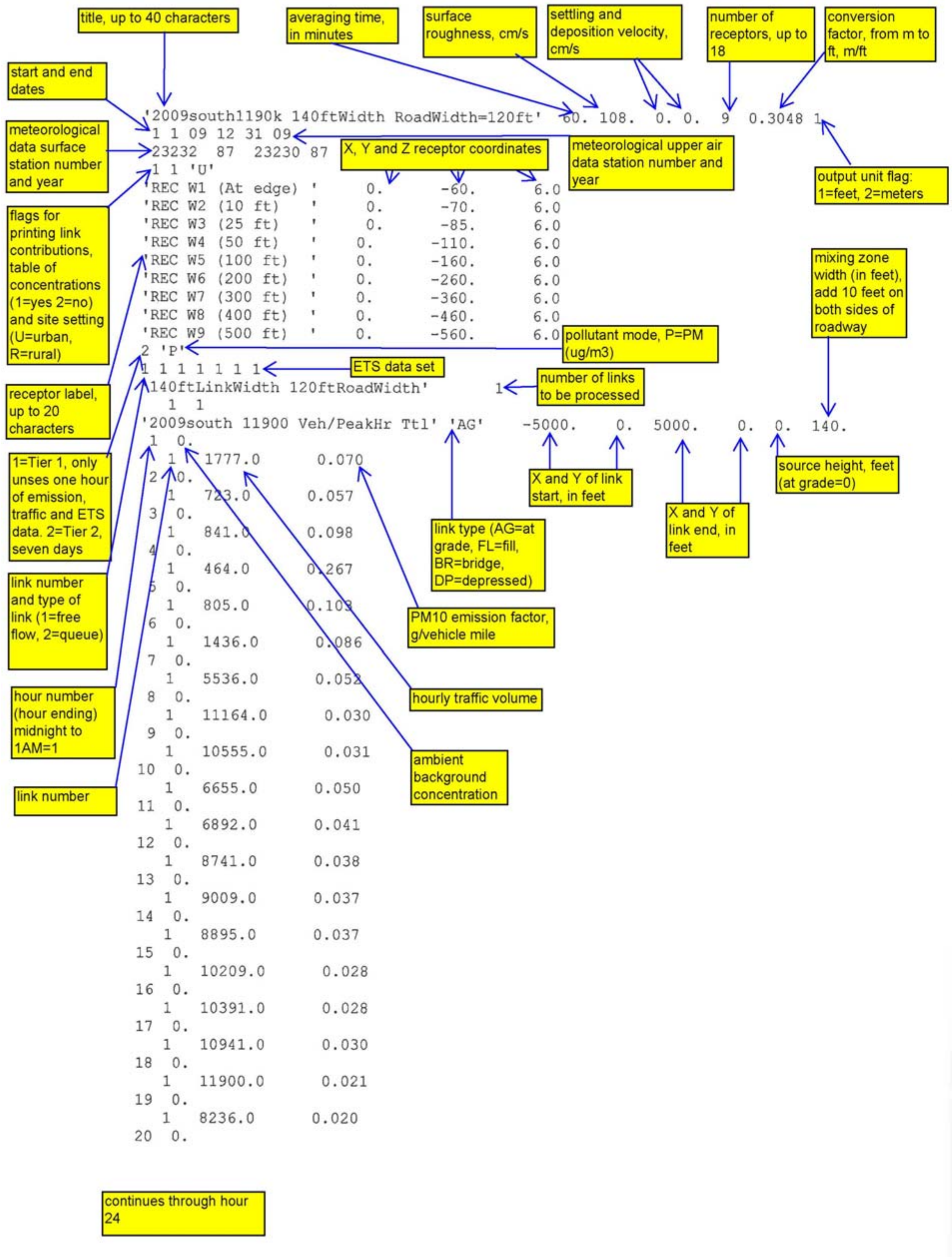
The executable file runs the program. This file will not be edited.

3.10.1.7.5Prepare the Input File (.inp)

The input file contains scenario parameters.

Prepare the input by editing over an example file provided with the model download, or by editing over a file provided by the local air district that more closely reflects the setup needed for this type of roadway modeling. Save the input file with the name of your run. See Figure 3.16 below for the example scenario input file and input explanations.

Figure 3.16: Example Scenario Input File and Input Explanations



3.10.1.8 Running the Model and Calculating Potential Cancer Risk

Double click on the .bat file to run the model. The model will produce a series of files with extensions .ET1, .ET2, .ILK, .OUT, .txt, and .ctl. Open the .txt and check to be sure the run was error-free.

The output file (.OUT) will show, among other information, the highest annual average concentrations. See Figure 3.17 below for the relevant section of the example scenario output file.

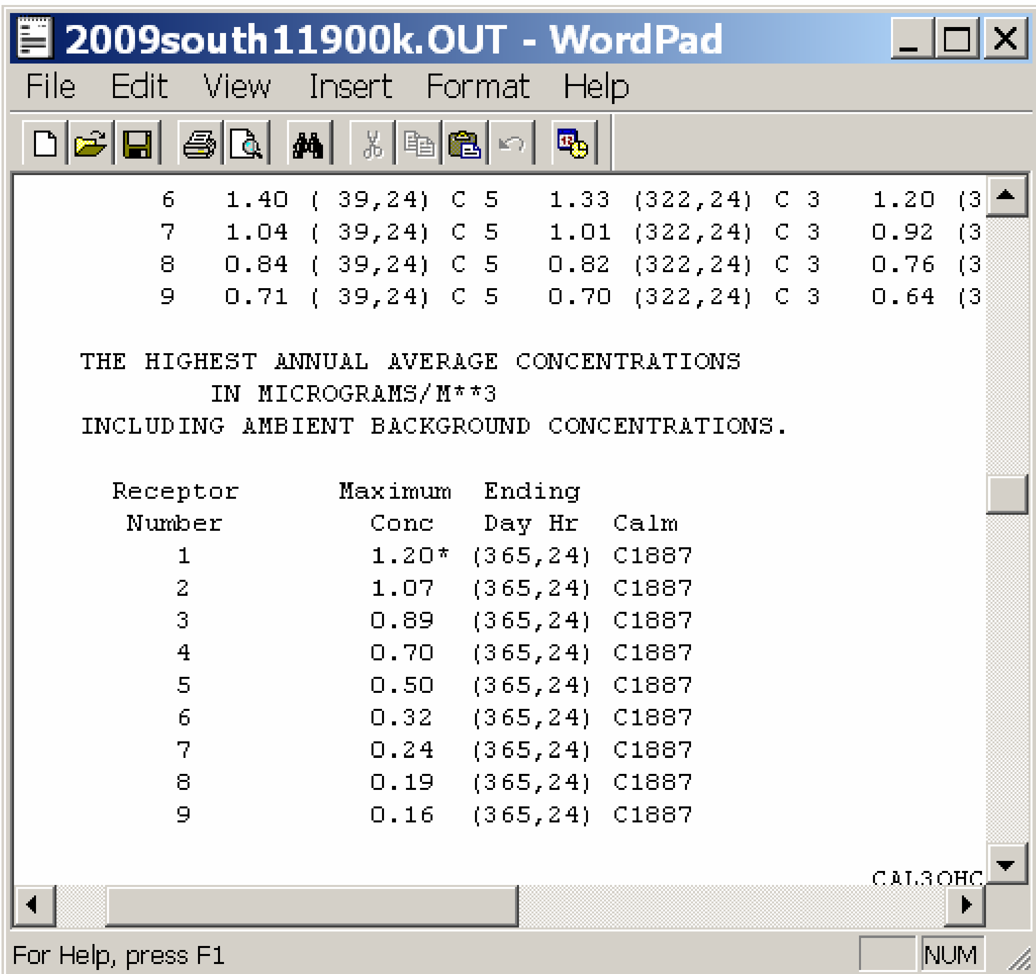


Figure 3.17: Example Scenario Output File, Highest Annual Average Concentrations

The example above shows downwind concentrations of diesel particulate matter at various receptor locations. The cancer risk due for diesel particulate is calculated by assuming that only the inhalation pathway applies. The default cancer risk calculation is based on the 80th percentile breathing rate, as recommended by the Office of Environmental Health Hazard Assessment. The cancer risk is calculated for receptor 4 (0.70 ug/m^3) as follows:

Cancer Risk = S_i * C_i * DBR * A * EF * ED / AT

Where:

S_i =	Cancer Potency Slope Factor for DPM	=	1.1 $(mg/kg\text{-}d)^{-1}$
C_i =	Concentration in the air of DPM	=	0.70 ug/m^3
DBR =	Daily Breathing Rate (default 80th %ile): (Residential Receptors)	=	302 L/kg-day
	(Some districts may require the use of the 95th %ile):	=	393 L/kg-day
A =	Inhalation Absorption Rate	=	1
EF =	Exposure Frequency: (Residential Receptors)	=	350 days
ED =	Exposure Duration: (Residential Receptors)	=	70 years
AT =	Averaging Time (70 years)	=	25,550 days

Cancer Risk:

= (1.1 $(mg/kg\text{-}d)^{-1}$)(0.70 ug/m^3)(302 L/kg-day)(1)(350 days)(70 years)/(25,550 days)

= 223 per million

3.10.1.9 Other CAL3QHCR Features

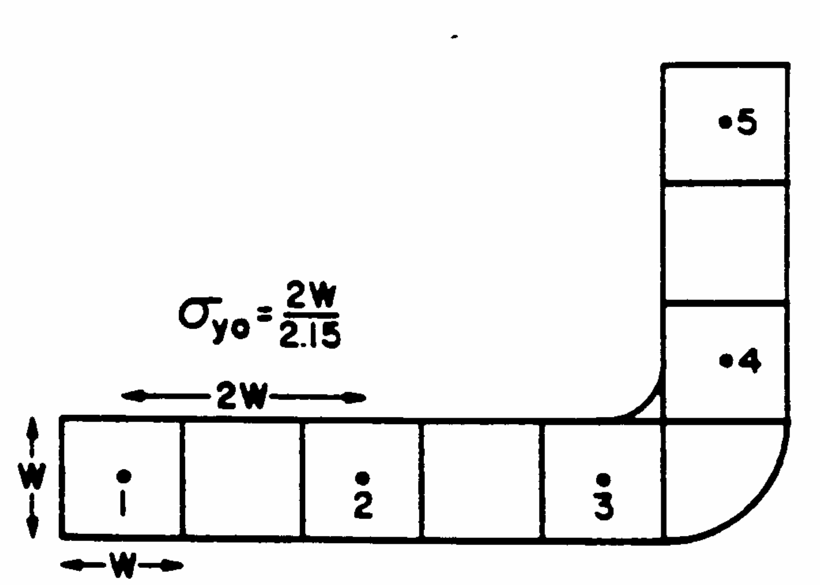
CAL3QHCR offers many other features that allow modeling traffic intersections, traffic signaling, and traffic queuing. Employing these features is quite site-specific. If these features must be employed, the user's guide should be consulted.

3.10.2 Modeling Roads using ISCST3 or AERMOD

CAL3QHCR is a roadway model. It can be used only to model highways. Often a project for which a health risk assessment is being prepared has additional sources. For example, a commercial development will have toxic emissions from truck idling, operation of transportation refrigeration units (TRUs), fast food restaurants, gasoline dispensing facilities, and dry cleaning operations. Large commercial operations may also have emergency diesel-fired internal combustion engines. These additional sources could be modeled in ISCST3 or AERMOD and their predicted risks superimposed upon those predicted by CAL3QHCR. Alternatively, all the sources including the roadways could be modeled using ISCST3 and AERMOD. The results of roadway modeling using ISCST3 and AERMOD are consistent with those from using CAL3QHCR. The procedures for using ISCST3 and AERMOD to model emissions from roadways are discussed below.

3.10.2.1 Introduction

ISCST3 and AERMOD can be used to predict the concentrations of pollutants emitted from vehicles on roads. These models have 4 basic types of sources (i.e., point, area, volume, and open pit). Emissions from idling vehicles located at a loading dock can be modeled as point sources. Area sources have been used in the past to model emissions from parking lots. The best method for modeling emissions from travelling vehicles is to use a line source or a series of multiple volume sources, as shown below.



View looking down along the length of a road segment (L_{RS})

The following steps can be used to construct a line source that represents diesel PM emissions from diesel trucks traveling along a road segment:

1. Determine the total emissions for the diesel trucks traveling along the road segment.

   E_T = Emissions total for road segment

2. Using the width of the road as the length of the side (W) of a single volume source, determine the number of volume sources along the length of the road by dividing the length of the road by 2W. Round the number of volume sources either up or down.

   W = Width of the road
   L_{RS} = Length of the road segment
   N = Number volume sources
   $N = L_{RS} / 2W$

3. Calculate the initial lateral dispersion:

$\sigma_y = 2W / 2.15$

3. Estimate the initial vertical dispersion using the height of the truck exhaust divided by 4.3.

$$\begin{aligned}\sigma_z &= H / 4.3 \\ &= 13 \text{ feet} / 4.3 \\ &= 3.01 \text{ feet}\end{aligned}$$

4. Calculate the emission rate for each volume source by dividing the total emissions for the road segment by the number of volume sources.

E_{VS} = Emission rate for each volume source
$E_{VS} = E_T / N$

5. Model each individual volume source using ISCST or AERMOD separately, but as a group, using actual emissions for each volume source.

6. Identify the predicted concentrations at each receptor.

7. Next, calculate the risk at each receptor using the procedure outlined above in Section 3.10.1.8.

3.10.2.2 Data Requirements

The data that are required to model roadway emissions using ISCST3 and AERMOD are similar to those required for using CAL3QHCR. They include the following:

- **Meteorological data** – If the air district cannot provide preprocessed meteorological data, then nearby airport or monitored surface data from a meteorological station can be processed for use in ISCST3 or AERMOD. Contact your local district for availability of appropriate met data. Information on processing met data can be found in Appendix A.
- **Traffic data and vehicle emissions** – The same data as discussed above for the CAL3QCHR model are used.
- **Roadway configuration** – The width of the roadway is used as the length of a side for each volume source. Receptors should be located the same as with the CAL3QCHR model.
- **Terrain data** – For ISCST3, elevation data must be entered manually. AERMAP is used to generate the elevations and hill slopes for receptors and sources for input to the AERMOD model. Digital Elevation Model (DEM) files for use in AERMAP are available from a variety of sources.

Third-party software used to prepare the input file for ISCST3, and used to allow the model results to be viewed graphically, can also be used to determine terrain elevations using DEM files.

Once these data are assembled, the model input file can be created.

3.10.2.3 Preparing the Model Input File

The input files for ISCST3 and AERMOD are very similar. In the discussion below, only the input file for the ISCST3 model will be described.

The input file must contain the following components or sections:

CO – for overall job control options
SO – for source information
RE – for receptor information
ME – for meteorological data
TG – for a terrain grid (optional)
OU – for output options

Each of these sections is discussed briefly below. For more detailed information, the *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models: Volume I – User Instructions* (EPA-454/B-95-003a) should be consulted.

3.10.2.3.1 Control Option Section

Each section begins with a STARTING command and ends with a FINISHED command. Model options that must be specified include: a title; model options such as default or "regulatory" dispersion options, rural or urban dispersion coefficients, and concentration or deposition estimates; the averaging time (period or annual for carcinogenic risk); the pollutant identification; and the RUNORNOT option. The following is a sample input for the example discussed above:

```
CO STARTING
   TITLEONE 2009south1190k
   MODELOPT DFAULT CONC  URBAN
   AVERTIME PERIOD
   POLLUTID DPM
   TERRHGTS ELEV
   FLAGPOLE 1.80
   RUNORNOT RUN
   ERRORFIL Road.err
CO FINISHED
```

In this sample input file, the regulatory default options are used. The model will calculate concentrations of DPM (i.e., diesel particulate matter) using urban dispersion coefficients. The receptors will all be modeled with a default height of 6 ft or 1.8 m. The model will run to completion and will output an error file.

3.10.2.3.2 Source Section

As discussed above, a series of volume sources will be modeled to simulate the roadway. The sample input file for this section is the following:

```
SO STARTING
** Source Location **
** Source ID - Type - X Coord. - Y Coord. **
** Line Source represented by Separated Volume Sources
** ------------------------------------------------------------------
** LINE Source ID = SLINE1
** DESCRSRC 2009south1190k
** Length of Side = 36.58
** Emission Rate = 0.123435368
** Elevated
** Vertical Dimension = 0.85
** SZINIT = 0.20
** Nodes = 2
** 309476.00, 3916500.00, 0.00, 3.66, 0.0
** 312527.00, 3916500.00, 0.00, 3.66, 33.38
** ------------------------------------------------------------------
   LOCATION L0000001 VOLUME 309494.288 3916500.000 0.00
   LOCATION L0000002 VOLUME 309566.060 3916500.000 0.00
   LOCATION L0000042 VOLUME 312436.939 3916500.000 0.00
   LOCATION L0000043 VOLUME 312508.711 3916500.000 0.00
** End of Line Source
** Source Parameters **
   SRCPARAM L0000001 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000002 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000042 0.00287058995348837 3.66 33.38 0.85
   SRCPARAM L0000043 0.00287058995348837 3.66 33.38 0.85
** Variable Emissions Type: "By Hour-of-Day"
** Variable Emission Scenario: "Scenario 1"
   EMISFACT L0000001 HROFDY 0.53 0.176 0.351 0.528 0.353 0.526
   EMISFACT L0000001 HROFDY 1.227 1.427 1.395 1.418 1.204 1.416
   SRCGROUP SRCGP1 L0000001 L0000002 L0000003 L0000004 L0000005 L0000006
   SRCGROUP SRCGP1 L0000043
SO FINISHED
```

In the above sample input, all lines with "**" are comments. This file was generated using an interface program for the model. In this interface, the information for the line source is input, and the program automatically generates the individual volume sources. As can be seen from the input file, there are 43 separate volume sources in this "line source". The location of the center of each volume source and its base elevation (i.e., 0 m) is given on the LOCATION command. The SRCPARAM commands specify the emission rate, the release height, the initial lateral dimension, and the initial vertical dimension. The average emission rate calculated from the information provided above was used. The program divides the emission rate for the line source by the number of volume sources.

A **release height** of 12 ft or 3.66 m was used to approximate the height of the plume from a heavy-duty diesel truck.

The width of the roadway was used as the **length of the side for each volume source**.

The length of the side is used to calculate an initial lateral dimension. For this example, the **initial lateral dimension** is 34.03 m or 2 x 36.58/2.15. (The initial lateral dimension actually used is 33.38 m to ensure that there are an equal number of volume sources in the length of road. This small difference in the calculated initial lateral dimension and the one actually used would not significantly affect the concentrations estimated.)

Based on this release height, an **initial vertical dimension** of 0.85 m or 3.66/4.3 was used.

Variable emission factors (EMISFACT) by the hour of the day (HROFDAY) were used to adjust the average emission rate by the appropriate factor based upon the discussion above for the CAL3QCHR run.

3.10.2.3.3Receptor Section

Receptors were located at the distances specified above in the discussion of CAL3QCHR modeling. The sample input file for this section is the following:

```
RE STARTING
** DESCRREC "FENCEGRD" "Receptors generated from Fenceline Grid"
   DISCCART    312530.00   3916454.00    0.00    1.80
   DISCCART    312505.15   3916454.00    0.00    1.80
** DESCRREC "FENCEPRI" "Cartesian plant boundary Primary Receptors"
   DISCCART    309473.00   3916457.00    0.00    1.80
   DISCCART    312530.00   3916457.00    0.00    1.80
   DISCCART    312530.00   3916543.00    0.00    1.80
   DISCCART    309473.00   3916543.00    0.00    1.80
** DESCRREC "FENCEINT" "Cartesian plant boundary Intermediate Receptors"
   DISCCART    309497.85   3916457.00    0.00    1.80
   DISCCART    309522.71   3916457.00    0.00    1.80
   DISCCART    309473.00   3916478.50    0.00    1.80
RE FINISHED
```

The interface program used allows the automatic creation of a telescopic fenceline grid around a facility. This feature was used to create the receptors in this sample input.

First, primary plant boundary receptors were located around the highway. The "plant boundary" was assumed to be the edge of the roadway (i.e., 10 ft on each side of the road from the roadway's width).

Intermediate receptors were located at a distance of 25 m between receptors along the edge of the roadway.

Then, tiers of receptors at distances of 10 ft, 25 ft, 50 ft, 100 ft, 200 ft, 300 ft, 400 ft, and 500 ft from the roadway edge were entered.

These grid receptors were converted to discrete receptors, and any extraneous receptors were removed.

Note that specific receptors for residences or other **sensitive receptors** could be modeled directly with the ISCST3/AERMOD model.

The **elevation of receptors** was assumed to be zero.

A **receptor height** of 6 ft or 1.8 m was used to approximate the breathing height.

3.10.2.3.4 Meteorology Section

The meteorology section specifies the meteorological data to be used. The sample input file for this section is the following:

```
ME STARTING
   INPUTFIL C:\MODELI~1\SACOAK85.asc
   ANEMHGHT 10 METERS
   SURFDATA 23232 1985 SACRAMENTO/EXECUTIVE_ARPT
   UAIRDATA 23230 1985 OAKLAND/WSO_AP
ME FINISHED
```

For this sample input file, the 1985 meteorological data from Sacramento was downloaded from the District's website. In the input file, the name and location of the met data file is specified. The height of the anemometer is given. (Most anemometers at airport weather stations are 10 m high.) And, the station number, year and name of the surface data and upper air stations are identified.

3.10.2.3.4 Output Section

The output section specifies the files or reports to be output. The sample input file for this section is the following:

```
OU STARTING
** Auto-Generated Plotfiles
   PLOTFILE PERIOD SRCGP1 ROAD.IS\PE00G001.PLT
OU FINISHED
```

ISCST3/AERMOD have a variety of files and reports that can be output. One of the most useful filetypes that can be output is the plotfile. A plotfile has the following information:

```
* ISCST3 (02035): 2009south1190k
* MODELING OPTIONS USED:
*  CONC                      URBAN ELEV  FLGPOL DFAULT
*         PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: SRCGP1
*         FOR A TOTAL OF  2236 RECEPTORS.
*         FORMAT: (3(1X,F13.5),1X,F8.2,2X,A6,2X,A8,2X,I8.8,2X,A8)
*        X             Y      AVERAGE CONC   ZELEV     AVE     GRP       NUM HRS   NET ID
* ___________  ___________  ___________  ______  ______  ________  ________  ________
  312530.00000 3916454.00000      0.13119     0.00  PERIOD  SRCGP1    00008760     NA
```

For each receptor and each specified source group, this file contains the highest predicted concentration for the specified averaging time. Multiple files can be created for multiple source groups (which can be single sources or multiple sources depending upon those specified by the user) and for each averaging time modeled. These plotfiles can be used to generate a *.XOQ file for input into the Hot Spots Analysis and Reporting Program (HARP). They also can be used by graphics programs incorporated into the model interface programs or software such as SURFER to generate isopleths of concentration for a visual display of the results.

3.10.2.4 Analyzing Model Results

Concentrations predicted by ISCST3/AERMOD can be used to estimate risk using the procedure discussed above for cancer risk from emissions of diesel particulate matter. The plotfiles generated by the models can be used to create an input file for HARP. Importing the results into HARP can be useful if there are other sources that may contribute to the total risk (e.g., in the case of a commercial development). All sources can be modeled in ISCST3/AERMOD while only the roadway sources can be modeled in CAL3QCHR.

Chapter 4. Geographical Information Inputs

4.1 Comparison of Screening and Refined Model Requirements

Geographical information requirements range from basic for screening analyses to advanced for refined modeling. SCREEN3 makes use of geographical information only for terrain data for complex or elevated terrain where it requires simply distance from source and height in a straight-line. The AERMOD and ISCST3/ISC-PRIME models make use of complete three-dimensional geographic data with support for digital elevation model files and real-world spatial characterization of all model objects.

4.2 Coordinate System

4.2.1 Local

Local coordinates encompass coordinate systems that are not based on a geographic standard. For example, a facility may reference its coordinate system based on a local set datum, such as a predefined benchmark. All site measurements can relate to this benchmark which can be defined as the origin of the local coordinate system with coordinates of 0.0 m. All facility buildings and sources could then be related spatially to this origin.

However, local coordinates do not indicate where in the actual world the site is located. For this reason, it is advantageous to consider a geographic coordinate system that can specify the location of any object anywhere in the world with precision. The coordinate system most commonly used for air dispersion modeling is the Universal Transverse Mercator system.

4.2.2 UTM

As described earlier, the Universal Transverse Mercator (UTM) coordinate system uses meters as its basic unit of measurement and allows for more precise definition of specific locations than latitude/longitude. Google Earth may be used to determine the UTMs or latitude/longitude coordinates.

Ensure all model objects (sources, buildings, receptors) are defined in the same horizontal datum. Defining some objects based on a NAD27 (North American datum of 1927) while defining others within a NAD83 (North American datum of 1983) can lead to significant errors in relative locations.

4.3 Terrain

4.3.1 Terrain Concerns in Short-Range Modeling

Terrain elevations can have a large impact on the air dispersion and deposition modeling results and therefore on the estimates of potential risk to human health and the environment. Terrain elevation is the elevation relative to the facility base elevation.

The following section describes the primary types of terrain. The consideration of a terrain type is dependant on your study area, and the definitions below should be considered when determining the characteristics of the terrain for your modeling analysis.

4.3.2 Flat and Complex Terrain

The models consider three different categories of terrain as follows:
Complex Terrain: as illustrated in Figure 4.1, where terrain elevations for the surrounding area, defined as anywhere within 50 km from the stack, are above the top of the stack being evaluated in the air modeling analysis.

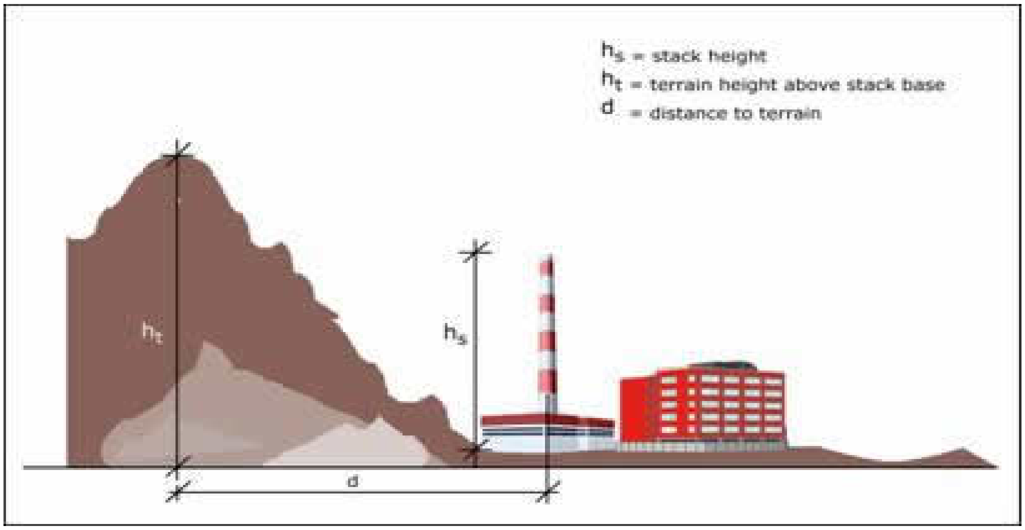


Figure 4.1 - Complex terrain conditions.

Simple Terrain: where terrain elevations for the surrounding area are not above the top of the stack being evaluated in the air modeling analysis. The "Simple" terrain can be divided into two categories:

- Simple Flat Terrain is used where terrain elevations are assumed not to exceed stack base elevation. If this option is used, then terrain height is considered to be 0.0 m.
- Simple Elevated Terrain, as illustrated in Figure 4.2 is used where terrain elevations exceed stack base but are below stack height.

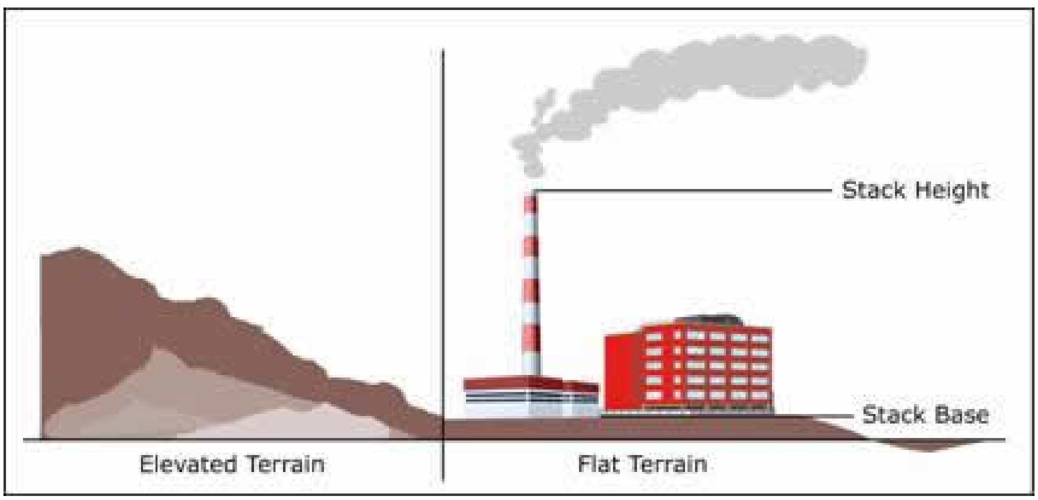


Figure 4.2 –Elevated and flat terrain conditions.

4.3.3 Criteria for Use of Terrain Data

Evaluation of the terrain within a given study area is the responsibility of the modeler. Complex terrain may need to be considered even in areas that appear to be relatively flat. It should be remembered that complex terrain is any terrain within the study area that is above the source release height.

The appropriate terrain environment can be determined through the use of digital elevation data or other geographic data sources. It should be noted that the refined models, ISCST3/ISC-PRIME and AERMOD, have similar run times regardless of whether or not terrain data is used. However AERMAP, the terrain pre-processor for AERMOD, does require additional time. If analysis of the terrain environment is performed using digital terrain data, minimal resources are required to execute a model run using that digital terrain dataset.

4.3.4 Obtaining Terrain Data

Terrain data that are input into the AERMOD and ISCST3/ISC-PRIME models should be provided in electronic form. Digital elevation terrain data is available from a variety of vendors in several different formats.

Digital elevation model (DEM) data are available for free from Lakes Environmental's Web GIS web page http://www.webgis.com.

4.3.5 Preparing Terrain Data for Model Use

It is strongly suggested that the 7.5-minute data be used in dispersion modeling rather than the coarse resolution 1 degree data. Keep in mind that the USGS DEMs can be in one of two horizontal datums. Older DEMs were commonly in NAD27 (North American Datum of 1927) while many of the latest versions are in NAD83 (North American Datum of 1983).

4.3.5.1 ISC / HARP

The ISCST3 model accepts elevation data for receptors and sources. This data should be obtained from the USGS topographic maps or Digital Elevation Model (DEM) files. USGS DEMs are available for California from ARB at (http://www.arb.ca.gov/toxics/harp/maps.htm) in 7.5-minute format for use in the ARB HARP program and from Lakes Environmental at http://www.webgis.com in 7.5 minute and 1 degree formats.

4.3.5.2 AERMOD

AERMAP is the digital terrain pre-processor for the AERMOD model. It analyzes and prepares digital terrain data for use within an air dispersion modeling project. AERMAP requires that the digital terrain data files be in native (non SDTS) USGS 1-degree or 7.5-minute DEM format.

4.4 Defining Urban and Rural Conditions

The classification of a site as urban or rural can be based on the Auer method specified in the EPA document *Guideline on Air Quality Models (40 CFR Part 51, Appendix W)*[37]. From the Auer's method, areas typically defined as Rural include:

---

[37] U.S. Environmental Protection Agency, 2001. Appendix W to Part 51 Guideline on Air Quality Models, 40 CFR Part 51. U. S. Environmental Protection Agency, Research Triangle Park, NC.

- Residences with grass lawns and trees
- Large estates
- Metropolitan parks and golf courses
- Agricultural areas
- Undeveloped land
- Water surfaces

Auer suggests that an area can be classified as Urban if it has less than 35% vegetation coverage or the area falls into one of the following use types:

Table 4.1 - Urban Land use

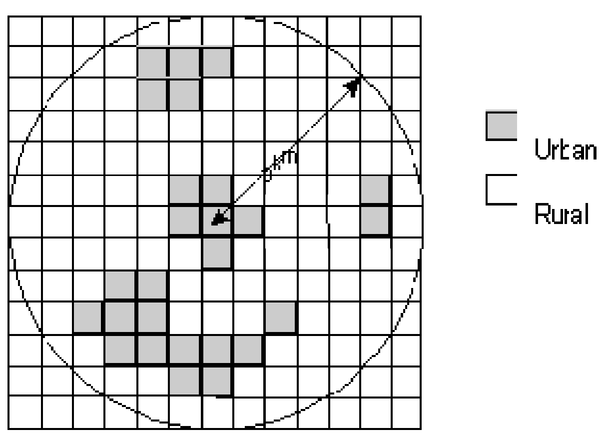
Type	Use and Structures	Vegetation
I1	Heavy industrial	Less than 5%
I2	Light/moderate industrial	Less than 5%
C1	Commercial	Less than 15%
R2	Dense single / multi-family	Less than 30%
R3	Multi-family, two-story	Less than 35%

Follow the Auer's method, explained below, for the selection of either urban or rural dispersion coefficients:

Step 1: Draw a circle with a radius of 3 km from the center of the stack or centroid of the polygon formed by the facility stacks.

Step 2: If land use types I1, I2, C1, R2, and R3 account for 50% or more of the area within the circle, then the area is classified as Urban, otherwise the area is classified as Rural.

To verify if the area within the 3 km radius is predominantly rural or urban, overlay a grid on top of the circle and identify each square as primarily urban or rural. If more than 50% of the total number of squares is urban than the area is classified as urban; otherwise the area is rural.[35]



An alternative approach to Urban/Rural classification is the Population Density Procedure: Compute the average population density, p, per square kilometer.

- If $p > 750$ people/km^2, select the Urban option,
- If $p <= 750$ people/km^2, select the Rural option.

Of the two methods above, the land use procedure is considered a more definitive criterion. The population density procedure should be used with caution and should not be applied to highly industrialized areas where the population density may be low and thus a rural classification would be indicated, but the area is sufficiently built-up so that the urban land use criteria would be satisfied. In this case, the classification should already be Urban and urban dispersion parameters should be used.

Prior to using either of the above methods, contact the district to determine whether the area in question has already been designated as urban or rural.

Chapter 5. Meteorological Data

5.0 Comparison of Screening and Refined Model Requirements

Meteorological data is essential for air dispersion model modeling as it describes the primary environment through which the pollutants being studied migrate. Similar to other data requirements, screening model requirements are less demanding than refined models.

SCREEN3 provides 3 methods of defining meteorological conditions:

- Full Meteorology: SCREEN will examine all six stability classes (five for urban sources) and their associated wind speeds. SCREEN examines a range of stability classes and wind speeds to identify the "worst case" meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum ground level concentrations.
- Single Stability Class: The modeler can select the stability class to be used (A through F). SCREEN will then examine a range of wind speeds for that stability class only.
- Single Stability Class and Wind Speed: The modeler can select the stability class and input the 10-meter wind speed to be used. SCREEN will examine only that particular stability class and wind speed.

Contact the district for guidance if full meteorology is not being used in SCREEN.

See Appendix A for information on preparing meteorological data for refined modeling (AERMOD and ISC.

Chapter 6. Receptor Locations

6.0 Receptors

A receptor is defined as a point where an actual person (residential or worker) may be located for a given period of time. The period of time is based on the type of assessment that is being performed. When an acute (1-hour or longer, as applicable) risk assessment is to be prepared, all locations where a person could be located for a one hour period needs to be identified. When a cancer or chronic risk assessment is to be prepared, all locations where a person could be located for extended periods of time, such as a residence or workplace, need to be identified.

6.0.1 Residential Receptors

Homes, apartments, motels, trailer parks, residential camp grounds, and other places where people reside for long periods are defined as residential receptors. When a cancer risk is prepared, the exposure period should be 70 years. For acute risk assessments, the exposure period should be 1 hour for those substances with acute toxicity values based on one hour exposure periods.

6.0.2 Worker Receptors

Worksites, schools, and other locations where people are exposed for long periods of time are defined as worker receptors. When a cancer risk is prepared, the exposure period should be 40 years. For acute risk assessments, the exposure period should be 1 hour for those substances with acute toxicity values based on one hour exposure periods.

6.0.3 Offsite Receptors

Offsite receptors are included in risk assessments when they are not employed by the project.

6.0.4 Onsite Receptors

Onsite receptors are included in risk assessments if they are persons not employed by the project.

6.0.5 Sensitive Receptors

Sensitive receptors are defined as the following:

- Schools
- Daycare facilities other than home based
- Hospitals
- Care facilities (adult/elderly)

At the present time, the risk assessment calculations do not calculate different risk values for sensitive receptors compared to other receptors. However, sensitive receptors must be identified. Contact the district to determine the area in which sensitive receptors must be identified. Some commonly used criteria are out to a distance of 2 kilometers from a project emission source or within the 1 in a million risk isopleth.

6.1 Receptor Grids

6.1.1 Cartesian Receptor Grids

Cartesian receptor grids are receptor networks that are defined by an origin with receptor points evenly (uniform) or unevenly (non-uniform) spaced around the origin. Figure 6.1 illustrates a sample uniform Cartesian receptor grid.

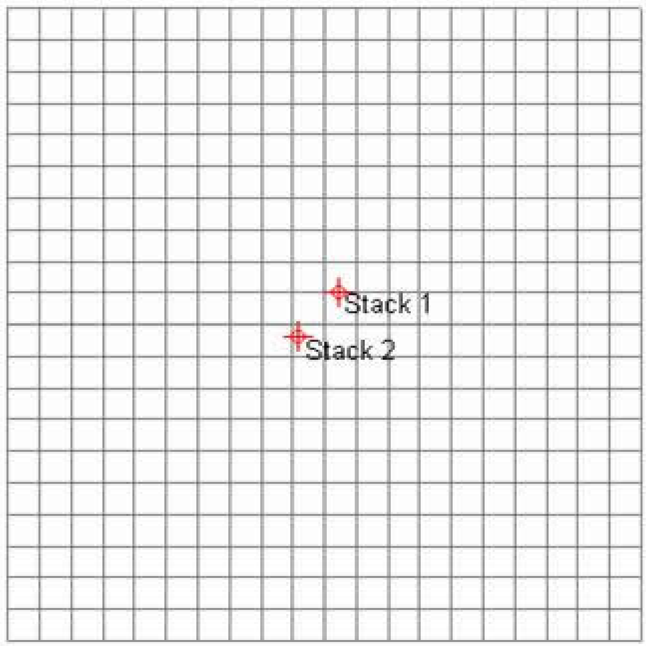


Figure 6.1 – Example of a Cartesian grid.

Tall stacks could require grids extending 1 to 3 km, while the grid for shorter stacks (10 to 20 m above ground) might only need to be extended a km or less from the property line.

6.1.2 Polar Receptor Grids

Polar receptor grids are receptor networks that are characterized by an origin with receptor points defined by the intersection of concentric rings, which have defined distances in meters from the origin, with direction radials that are separated by specified degree spacing. Figure 6.2 illustrates a sample uniform polar receptor grid.

Polar grids are a reasonable choice for facilities with only one source or one dominant source. However, for facilities with a number of significant emissions sources, receptor spacing can become too coarse when using polar grids. As a result, polar grids should generally be used in conjunction with another receptor grid, such as a multi-tier grid, to ensure adequate spacing.

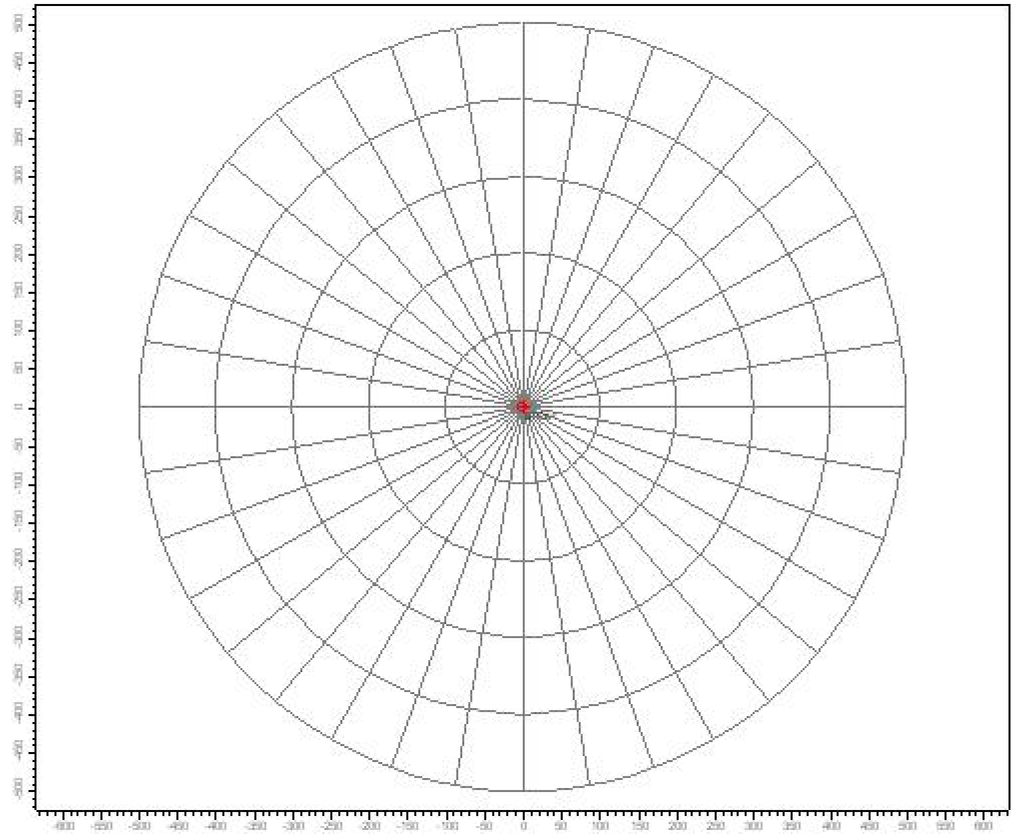


Figure 6.2 – Example of a polar grid.

6.1.3 Multi-Tier Grids

Each receptor point requires computational time. Consequently, it is not optimal to specify a dense network of receptors over a large modeling area; the computational time would negatively impact productivity and available time for proper analysis of results. An approach that combines aspects of coarse grids and refined grids in one modeling run is the multi-tier grid.

The multi-tier grid approach strives to achieve proper definition of points of maximum impact while maintaining reasonable computation times without sacrificing sufficient resolution. Figure 6.3 provides an example of a multi-tier grid.

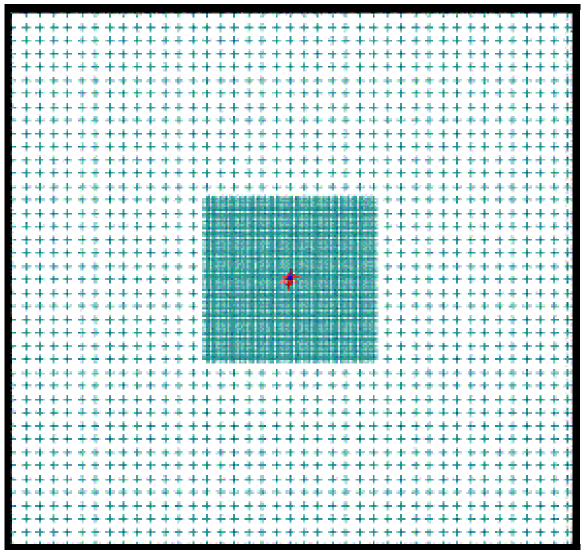


Figure 6.3 - Sample Multi-Tier Grid with 2 tiers of spacing.

6.1.4 Fence line Receptors

Unless on-site receptors are present, it is not necessary to model the locations within a property boundary. If on-site receptors may be present, contact the District concerning receptor placement. If a fence line receptor point does not represent an existing or reasonably anticipated person, it is not necessary to consider these results to determine the Maximum Exposed Individual (MEI), but fence line exposure should be considered to determine the Point of Maximum Impact (PMI).

A receptor network based on the shape of the property boundary that has receptors parallel to the boundaries is often a good choice for receptor geometry. The receptor spacing can then progress from fine to coarse spacing as distance increases from the facility, similar to the multi-tier grid.

6.1.5 Discrete & Sensitive Receptors

Receptor grids do not always cover precise locations that may be of interest in modeling projects. Specific locations of concern can be modeled by placing single receptors, or additional refined receptor grids, at desired locations. This enables the modeler to generate data on specific points for which data is especially critical. Examples of specific locations can include:

- Apartments,
- Residential zones,
- Schools,
- Apartment buildings,
- Day care centers,
- Air intakes on nearby buildings,
- Hospitals,
- Parks,
- Care Facilities, or

- Elevated receptors, such as balconies or air intakes on multilevel buildings, as concentrations of toxic substances can be higher there than at ground level.

Depending on the project resolution and location type, these can be characterized by discrete receptors, a series of discrete receptors, or an additional receptor grid.

6.2 Variable Receptor Spacing to include the Point of Maximum Impact (PMI)

The receptor grid must be designed to include the Point of Maximum Impact (PMI). For facilities with more than one emission source, the receptor network should include Cartesian or multi-tier grids to ensure that maximum concentrations are obtained. An indication as to the PMI can be determined by using SCREEN3 or AERSCREEN applied to the most significant sources at a facility.

The model could be first run with a coarser grid, and then run with finer grids in the areas showing the highest impacts. If this method is used, finer grids, as described above, should be used for all areas with high concentrations, not just the single highest area.

The densities of the receptors can progress from fine resolution near the source, centroid of the sources, or most significant source (not from the property line for polar grid) to coarser resolution farther away. Section 6.1.3 shows an example of multiple grid spacing to ensure that the maximum ground level offsite property concentrations are captured.

Receptors should also be placed along the property boundaries. The spacing of these receptors depends on the distance from the emission sources to the facility boundaries. For cases with emissions from short stacks or vents and a close property line, a receptor spacing of 25 m might be required. For taller stacks and greater distances to the property boundary, a receptor spacing greater than 25 m might be appropriate.

It is the responsibility of the modeler to demonstrate that the PMI has been identified and that the modeling includes all areas where Hazard Indices are above one, and the cancer risk is above ten per million, or other district standards.

6.2.1 Example Polar Grid Spacing

- 36 Directional Radials
- Radial Distances:
  - 25 m
  - 50 m
  - 100 m
  - 250 m
  - 500 m

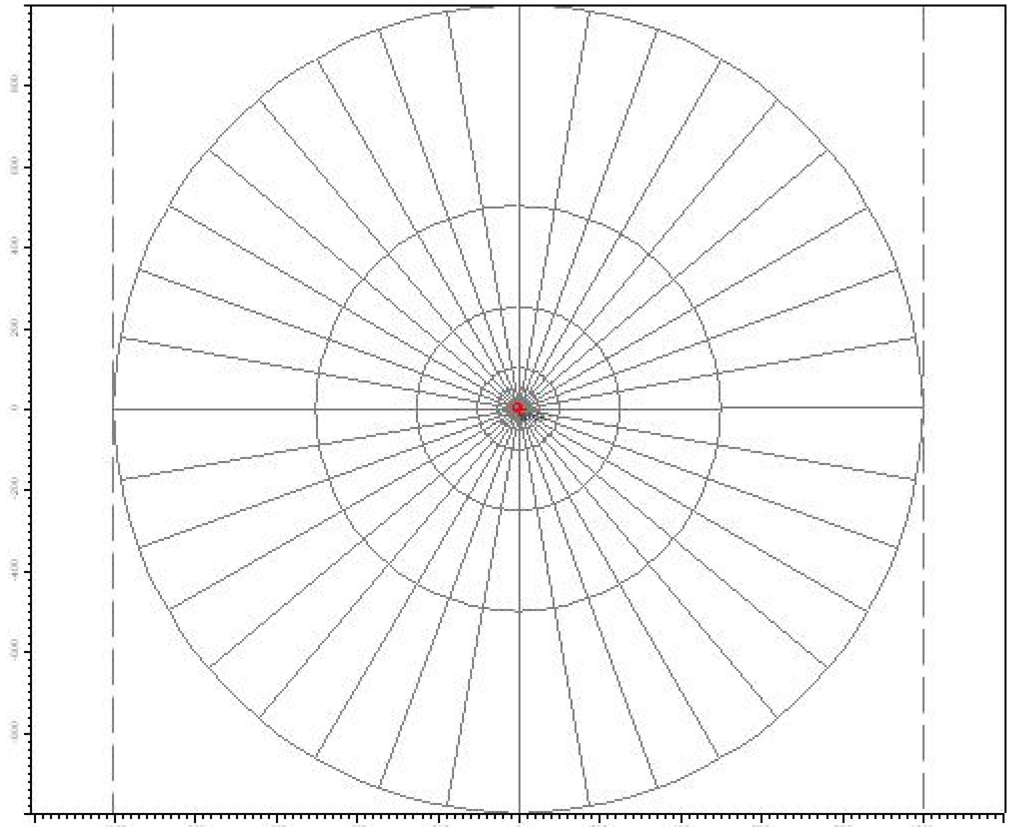


Figure 6.4 – Sample Polar Grid receptor grid layout.

Chapter 7. Other Modeling Considerations

7.0 Alternative Model Use

Due to some limitations inherent in AERMOD (and most other plume models), there are some situations where the use of an alternative model may be appropriate. Acceptable Alternative Models and their use are further described on EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) web page.

AERMOD is a steady-state plume model. For the purpose of calculating concentrations, the plume is assumed to travel in a straight line without significant changes in stability as the plume travels from the source to a receptor. At distances on the order of tens of kilometers downwind, changes in stability and wind are likely to cause the accuracy to deteriorate. For this reason, AERMOD should not be used for modeling at receptors beyond 50 kilometers. AERMOD may also be inappropriate for some near-field modeling in cases where the wind field is very complex due to terrain or a nearby shoreline.

AERMOD does not treat the effects of shoreline fumigation. Shoreline fumigation may occur along the shore of the ocean or large lake. When the land is warmer than the water, a sea breeze will form as the warmer lighter air inland rises. As the stable air from over the water moves inland, it is heated from below, resulting in a turbulent boundary layer of air that rises with downwind distance from the shoreline. The plume from a stack source located at the shoreline may intersect the turbulent layer and be rapidly mixed to the ground, a process called "fumigation," resulting in high concentrations. In these and other situations, the use of alternative models may be desired.

The use of any alternative model should first be reviewed by the district for suitability to the study application. If an alternative model is used the reasons and argument for its use over a preferred model must be discussed. An understanding of the alternative model, its data requirements, and the quality of data applied with the model must be demonstrated.

7.1 Use of Modelled Results in Combination with Monitoring Data

Monitoring and modeling should be considered complementary tools to assess potential impacts on the local community.

Monitoring data could be used to provide verification of model results if sufficient monitoring data is available at locations impacted by facility emissions. Decisions on the adequacy of the monitoring data would be made on a case-by-case basis. Comparisons between measured and modeled results would depend on the amount of monitored data available. Advance consultation with the district is advisable if a comparison of model results with monitoring data is undertaken.

If model results do not agree with measured data, the facility source characteristics and emission data should be reviewed.

For cases where reliable information is available on the emission rates and source characteristics for a facility, modeled results can identify maximum impact areas and concentration patterns that could assist in siting monitors. Model runs using a number of years of meteorological data would show the variations in the locations and the magnitude of maximum concentrations and can also provide information on the frequency of high concentrations.

The U.S. EPA Guideline on Air Quality Models states that modeling is the preferred method for determining concentrations and that monitoring alone would normally not be accepted for determining emission limitations.

When monitoring data are used to verify modeling results for averaging times from 1 to 24 hours, more robust comparisons would be achieved using a percentile of the data rather than only the maximum concentrations. Percentile comparisons reduce the impacts of outliers in either the monitoring or the model results. For some contaminants, the impact of background sources on measured concentrations might need to be taken into consideration.

7.2 Information for Inclusion in a Modeling Assessment

A suggested checklist of parameters designed to provide an overview of all information that should be submitted for a refined air dispersion modeling assessment is outlined in Appendix B.

The checklist should not be considered exhaustive for all modeling studies; it provides the essential requirements for a general assessment. All sites can have site-specific scenarios that may call for additional information and result in a need for different materials and data to be submitted.

It is the responsibility of the submitter to ensure proper completion and analysis of any air dispersion modeling assessment delivered for review.

7.3 Level of Detail of Health Risk Assessments

Generally, a health risk assessment for CEQA purposes must include all sources of emissions that will emanate from a project. This includes existing and proposed facility-wide emissions. This includes all sources of potential emissions whether or not the project is subject to district permitting requirements. Additionally, all substances that the Office of Environmental Health Hazard Assessment has identified as having toxicity values must be included in the health risk assessment; some districts may allow a less detailed risk assessment.

It is not permissible to omit permitted sources in a CEQA risk assessment, even if these sources will be evaluated during the permit process. The permitting process does not evaluate the cumulative risk associated with the entire facility, only the individual permit unit. A challenge to the completeness of the risk assessments can be made if these sources are not included in the analysis.

It is also not permissible to omit criteria pollutants in the facility risk assessment, assuming that these emissions will be evaluated separately. Criteria pollutants have OEHHA approved RELs that must be included in the chronic and acute hazard indices. Again, a challenge to the completeness of the risk assessments can be made if these substances are omitted.

Chapter 8. Exposure Assessment Procedures

8.0 Cancer Risk Assessment Procedure for Inhalation Only Pathway Pollutants

The following procedure may be used to assess the health risks from facilities for which diesel particulate matter is emitted or other substances identified as only entering the body through the inhalation pathway. Risk Assessments involving substances that enter the body through other pathways must be analyzed for each pathway. A risk assessment involving multipathway substances can to be prepared using the HARP program available through the California Air Resources Board.

Cancer Risk Procedure for Inhalation only Substances:

- Model emissions to determine both the:
  - annual average ground-level concentrations, and the
  - one hour maximum concentration (or other period depending on the acutely toxic substance)
- Create a plot file for these ground-level concentrations.
- Open the plot file using Microsoft EXCEL or another spreadsheet program.
- Copy the data from the plot(s) into Excel.
- To determine the cancer risk, apply the following formula to each ground-level concentrations:

Cancer Risk = S_i * C_i * DBR * A * EF * ED *10^{-6} / AT

Where:

S_i = Slope Factor for substance i
C_i = Concentration in the air of substance i
DBR = Daily Breathing Rate:

Residential Receptors = 302 L/kg-day (default 80^{th} %ile)
= 393 L/kg-day (95^{th} %ile)

Worker Receptors = 149 L/kg-day

A = Inhalation Absorption Rate = 1

EF = Exposure Frequency:

Residential Receptors = 350 days

Worker Receptors = 245 days

ED = Exposure Duration:

See Section 1.3

AT = Averaging Time = 25,550 days

The result will be cancer risk for each source and receptor combination modeled.

For worker exposures, in addition to adjusting the breathing rate, exposure frequency, and exposure duration for workers bersus residents, the emission rate must be adjusted to ensure that he worker risk is based upon the pollutant concentrations to which the worker is exposed. For additional information, see Section 8.2.2b of OEHHA's Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, August 2003.

8.1 Cancer Risk Assessment Procedure for Multi-Pathway Pollutants

The procedure for preparing a multi-pathway risk assessment can be complex. The HARP User Guide and the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines contains a detailed discussion of how to prepare multi-pathway risk assessments. These documents and others can be found on the CARB website at http://www.arb.ca.gov/toxics/harp/docs.htm.

8.2 Chronic Noncancer Health Impacts

The procedure for determining the impact of chronically toxic substances is described in detail in the OEHHA state guidelines[38]. Noncancer chronic inhalation impacts are calculated by dividing the annual average concentration by the REL (Reference Exposure Level) for that substance. The REL is defined as the concentration at which no adverse noncancer health effects are anticipated. For a single substance, this result of this calculation is called the Hazard Quotient. The following equation is used to calculate the Hazard Quotient:

Hazard Quotient = C_i/REL_i

Where:
C_i = Concentration in the air of substance i
REL_i = Chronic noncancer Reference Exposure Level for substance i

For multiple substances, the Hazard Index (HI) is calculated. The HI is calculated by summing the HQs from all substances that affect the same organ system. HQs for different organ systems are not added, for example, do not sum respiratory irritation HQs with cardiovascular effects. The following equation is used to calculate the Hazard Index for the eye irritation endpoint:

Hazard Index (HI_{eye}) = $HQ_{\text{substance 1(eye)}} + HQ_{\text{substance 2(eye)}}$

No exposure duration adjustment (e.g., 9/70) should be made for noncancer assessments.

For a chronic noncancer assessment involving multipathway pollutants, the California Air Resources Board HARP model can be used.

8.3 Acute Noncancer Health Impacts

The procedure for determining the impact of acutely toxic substances is also described in detail in the OEHHA state guidelines[39]. The calculation of acute noncancer impacts is similar to the procedure for chronic noncancer impacts. In most cases, for a single substance, the acute Hazard Quotient is the highest one hour air concentration divided by the acute REL for that substance. There are a few substances that have acute RELs for exposure periods other than 1 hour. In those cases, the maximum air concentration for the appropriate exposure period (e.g., 8 hours) is divided by the acute REL.

As with the chronic noncancer calculation, for multiple substances that impact the same organ system, the individual substance HQs are summed to determine the HI.

No exposure period adjustments are necessary for acute health impact calculations.

Acute exposures are calculated for the inhalation pathway only.

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[38] OEHHA Air Toxics Hot Spots Program Guidance Manual for the Preparation of Risk, June 2002

Appendix A

Meteorological Data

1.0 Preparing Meteorological Data for Refined Modeling

AERMOD and ISC models require actual hourly meteorological conditions as inputs. The refined models require pre-processed meteorological data that contains information on surface characteristics and upper air definition. This data is typically provided in a raw or partially processed format that requires processing through a meteorological pre-processor. The ISC models make use of a pre-processor called PCRAMMET, while AERMOD uses a pre-processor known as AERMET described further in the following sections.

Airport surface data is available from the National Climatic Data Center (NCDC) and other sources. Mixing height data or upper air data were available from NCDC. If mixing heights have not been calculated for the year of interest, mixing height software is available from EPA for use in calculating mixing heights from upper air data. AERMET is used to process upper air and surface data for use in AERMOD. Unlike PCRAMMET, AERMET produces 2 files: a surface file (*.sfc) and a profile file (*.pfl).

1.1 Surface Data

1.1.1 Screening Meteorological Data

Screening surface data may be used in ISC when no applicable surface data is available for the area to be modeled. Most user interface on the market today can generate screening meteorological data for ISC. Please contact the district before using screening meteorological data to ensure that no data is available for the area of concern.

1.1.2 Hourly Meteorological Data

Hourly surface data is supported in several formats including:

- CD-144 – NCDC Surface Data: This file is composed of one record per hour, with all weather elements reported in an 80-column card image. Table 1.0 lists the data contained in the CD-144 file format that is needed to pre-process your meteorological data.

Table 1.0 – CD-144 Surface Data Record (80 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	39-40
Wind Speed (Knots)	41-42
Dry Bulb Temperature (° Fahrenheit)	47-49
Opaque Cloud Cover	79

- MET-144 – SCRAM Surface Data: The SCRAM surface data format is a reduced version of the CD-144 data with fewer weather variables (28-character record). Table 1.1 lists the data contained in the SCRAM file format.

Table 1.1 - SCRAM Surface Data Record (28 Byte Record)

Element	Columns
Surface Station Number	1-5
Year	6-7
Month	8-9
Day	10-11
Hour	12-13
Ceiling Height (Hundreds of Feet)	14-16
Wind Direction (Tens of Degrees)	17-18
Wind Speed (Knots)	19-21
Dry Bulb Temperature (° Fahrenheit)	22-24
Total Cloud Cover (Tens of Percent)	25-26
Opaque Cloud Cover (Tens of Percent)	27-28

- The SCRAM data does not contain the following weather variables, which are necessary for dry and wet particle deposition analysis:
  - Surface pressure: for dry and wet particle deposition;
  - Precipitation type: for wet particle deposition only; or
  - Precipitation amount: for wet particle deposition only.

- SAMSON Surface Data: The SAMSON data contains all of the required meteorological variables for concentration, dry and wet particle deposition, and wet vapor deposition.
- NCDC data can be purchase online from the following web site: http://cdo.ncdc.noaa.gov/qclcd/QCLCD

If the processing of raw data is necessary, the surface data must be in one of the above formats in order to successfully pre-process the data using PCRAMMET or AERMET.

2.0 Mixing Height and Upper Air Data

Upper air data, also known as mixing height data, are required for pre-processing meteorological data required to run the ISC models. It is recommended that only years with complete mixing height data be used. In some instances, mixing height data may need to be obtained from more than one station to complete multiple years of data.

Mixing height data are available from:
- SCRAM BBS –download free of charge, mixing height data for the U.S. for years 1984 through 1991.
- WebMET.com –download free of charge, mixing height and upper air data from across North America, including Ontario.
- Free Upper air data can be downloaded from following web site (FSL Format) http://raob.fsl.noaa.gov/
- Table 2.1 lists the format of the mixing height data file used by PCRAMMET.

Table 2.1 - Upper Air Data File (SCRAM / NCDC TD-9689 Format)

Element	Columns
Upper Air Station Number (WBAN)	1-5
Year	6-7
Month	8-9
Day	10-11
AM Mixing Value	14-17
PM Mixing Value (NCDC)	25-28
PM Mixing Value (SCRAM)	32-35

AERMOD requires the full upper air sounding, unlike ISCST3/ISC-PRIME, which only require the mixing heights. The upper air soundings must be in the NCDC TD-6201 file format or one of the FSL formats.

2.1 AERMET and the AERMOD Model

The AERMET program is a meteorological preprocessor that prepares hourly surface data and upper air data for use in the U.S. EPA air quality dispersion model AERMOD. AERMET was designed to allow for future enhancements to process other types of data and to compute boundary layer parameters with different algorithms.

AERMET processes meteorological data in three stages:

- The first stage (Stage1) extracts meteorological data from archive data files and processes the data through various quality assessment checks.
- The second stage (Stage2) merges all data available for 24-hour periods (surface data, upper air data, and on-site data) and stores these data together in a single file.
- The third stage (Stage3) reads the merged meteorological data and estimates the necessary boundary layer parameters for use by AERMOD.

Out of this process two files are written for AERMOD:

- A Surface File of hourly boundary layer parameters estimates;
- A Profile File of multiple-level observations of wind speed, wind direction, temperature, and standard deviation of the fluctuating wind components.

2.2 PCRAMMET

The PCRAMMET program is a meteorological preprocessor, which prepares NWS data for use in the various U.S. EPA air quality dispersion models such as ISCST3/ISC-PRIME.

PCRAMMET is also used to prepare meteorological data for use by the CAL3QHCR model.

The operations performed by PCRAMMET include:

- Calculating hourly values for atmospheric stability from meteorological surface observations;
- Interpolating the twice daily mixing heights to hourly values;
- Optionally, calculating the parameters for dry and wet deposition processes;
- Outputting data in the standard (PCRAMMET unformatted) or ASCII format required by regulatory air quality dispersion models.

The input data requirements for PCRAMMET depend on the dispersion model and the model options for which the data is being prepared. The minimum input data requirements for PCRAMMET are:

- The twice-daily mixing heights,
- The hourly surface observations of: wind speed, wind direction, dry bulb temperature, opaque cloud cover, and ceiling height.

For dry deposition estimates, station pressure measurements are required. For wet deposition estimates, precipitation type and precipitation amount measurements for those periods where precipitation was observed are required.

The surface and upper air stations should be selected to ensure they are meteorologically representative of the general area being modeled.

2.3 Regional Meteorological Data

The district has/may prepare regional meteorological data sets for use in Tier 2 modeling in several formats. Please contact the District to determine what data is available:

- Regional pre-processed model ready data for AERMOD, with land characteristics for RURAL and URBAN conditions.
- Regional Merge files enabling customized surface characteristics to be specified and processed through AERMET Stage3.
- Hourly surface and upper air data files preprocessed for use in ISCST.

2.3.1 Pre-Processing Steps

Regional data for AERMOD can be processed in 2 forms:

- Merged: Data that has been processed through Stage2 of AERMET (AERMET stages are described in Section 7.1.3) to produce a “Merge” file. This file can then be processed through AERMET Stage3 with custom surface condition data to produce a meteorological data set specific to the site for use with AERMOD (Tier 3).
- Regional: Data that has been processed through Stage3 of AERMET with predefined Land Use characteristics for “Urban” and “Rural” environments. This data is ready for use with AERMOD (Tier 2).

2.3.1.1 Regional Meteorological Data Processing Background

Regional meteorological datasets are generated in AERMET, Stage3 processing step, using different wind independent surface conditions. It is assumed that surface conditions can be a weighted average over a radius of 3 km from the meteorological station and split into 12 sectors, or processed with other parameters approved by the district. The surface conditions needed are the albedo (A), the Bowen ratio (Bo) and the surface roughness (Zo). These parameter values can be derived from data in Tables 6.1, 6.2, 6.3 and 4.3 of the AERMET User’s Guide[1].

[1] U.S. Environmental Protection Agency, 1998. Revised Draft - User’s Guide for the AERMOD Meteorological Preprocessor (AERMET). Office of Air Quality Planning and Standards, Research Triangle Park, NC.

2.4 Availability and Use of District Meteorological Data

The district may provide meteorological data sets that can be used for air quality studies using ISCST or AERMOD. The data sets should not be modified. Use of custom meteorological data that is locally representative of site conditions can be created and applied for Tier 3 modeling analyses with district approval.

Meteorological data quality is of critical importance, particularly for reliable air dispersion modeling using refined models such as AERMOD. Meteorological data should be collected, processed and analyzed throughout the entire creation phase for completeness and quality control. Missing meteorological data and calm wind conditions can be handled by using EPA's missing data guidance document written by Russ Lee or guidance provided by the District.

The following factors determine the appropriateness of a meteorological data set, the:

- proximity of the meteorological site to the area being modeled,
- complexity of the terrain,
- exposure of the meteorological measurement site, and the
- time period of the data collection.

It should be emphasized that both the spatial and temporal aspects of the data set are the key requirement for determining the appropriateness of a meteorological data set. Not one, but all of these factors must be considered.

The meteorological data that is input to a model should be selected based on its appropriateness for the modeling project. More specifically, the meteorological data should be representative of the wind flow in the area being modeled, so that it can properly represent the transport and diffusion of the pollutants being modeled.

2.5 Expectations for Local Meteorological Data Use

Local meteorological data must be quality reviewed and the origin of the data and any formatting applied to the raw data must be outlined. The regulatory agency should review the plans to use local meteorological data prior to submission of a modeling report.

The sources of all of the data used including cloud data and upper air data must be documented. The proponent also needs to describe why the site chosen is representative for the modeling application. This would include a description of any topographic impacts or impacts from obstructions (trees, buildings etc.) on the wind monitor. Information on the heights at which the wind is measured is also required. The time period of the measurements along with the data completeness and the percentage of calm winds should be reported.

Wind roses showing the wind speed and directions should be provided with the modeling assessment. If wind direction dependent land use was used in deriving the final meteorological file, the selection of the land use should be described.

3.0 Land Use Characterization (AERMOD only)

Land use plays an important role in air dispersion modeling from meteorological data processing to defining modeling characteristics such as urban or rural conditions. Land use data can be obtained from digital and paper land-use maps.

These maps will provide an indication into the dominant land use types within an area of study, such as industrial, agricultural, forested and others. This information can then be used to determine dominant dispersion conditions and estimate values for parameters such as surface roughness, albedo, and Bowen ratio.

- Surface Roughness Length [m]: The surface roughness length, also referred to surface roughness height, is a measure of the height of obstacles to the wind flow. Surface roughness affects the height above local ground level that a particle moves from the ambient airflow above the ground into a "captured" deposition region near the ground. This height is not equal to the physical dimensions of the obstacles, but is generally proportional to them. Table 1.4 lists typical values for a range of land-use types as a function of season.

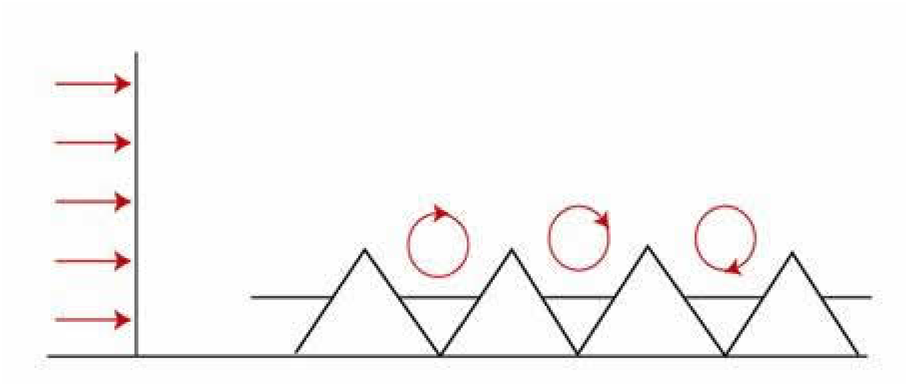

Figure 1.0 - For many modeling applications, surface roughness can be considered to be on the order of one tenth of the height of the roughness elements.

EPA has developed a modeling tool called AERSURFACE[2] to aid in obtaining realistic and reproducible surface characteristic values of albedo, Bowen ratio, and surface roughness length, for input to AERMET. The tool uses publicly available national land cover datasets and look-up tables of surface characteristics that vary by land cover type and season. AERSURFACE calculates the following 3 parameters for input into AERMET:

[2] AERSURFACE User's Guide, EPA-454/B-08-001 January 2008, http://www.epa.gov/scram001/dispersion_related.htm#aersurface

- Surface Roughness:
  The determination of the surface roughness length should be based on an inverse distance weighted geometric mean for a default upwind distance of 1 kilometer relative to the measurement site. Surface roughness length may be varied by sector to account for variations in land cover near the measurement site; however, the sector widths should be no smaller than 30 degrees.

- Bowen Ratio:
  The determination of the Bowen ratio should be based on a simple unweighted geometric mean (i.e., no direction or distance dependency) for a representative domain, with a default domain defined by a 10km by 10km region centered on the measurement site.

- Albedo:
  The determination of the albedo should be based on a simple unweighted arithmetic mean (i.e., no direction or distance dependency) for the same representative domain as defined for Bowen ratio, with a default domain defined by a 10km by 10km region centered on the measurement site.

AERMOD allows wind direction dependent surface characteristics to be used in the processing of the meteorological data. The AERMET procedure also uses the area-weighted average of the land use within 3 km of the site. The selection of wind direction dependent sectors is described in sections 3.1 to 3.3.

Alternative methods of determining surface roughness height may be proposed. The district should review any proposed values prior to use.

Table 3.1 –USGS NLCD92 Land Cover Categories used in AERSURFACE

Classification	Class Number	Land Cover Category
Water	11	Open Water
	12	Perennial Ice/Snow
Developed	21	Low Intensity Residential
	22	High Intensity Residential
	23	Commercial/Industrial/Transportation
Barren	31	Bare Rock/Sand/Clay
	32	Quarries/Strip Mines/Gravel Pits
	33	Transitional
Forested Upland	41	Deciduous Forest
	42	Evergreen Forest
	43	Mixed Forest
Shrubland	51	Shrubland
Non-natural Woody	61	Orchards/Vineyards/Other
Herbaceous Upland	71	Grasslands/Herbaceous
Herbaceous Planted/Cultivated	81	Pasture/Hay
	82	Row Crops
	83	Small Grains
	84	Fallow
	85	Urban/Recreational Grasses
Wetlands	91	Woody Wetlands
	92	Emergent Herbaceous Wetlands

Table 3.2 –AERSURFACE Seasonal Category Description

Seasonal Category	Season Description	Default Month Assignments
1	Midsummer with lush vegetation	Jun, Jul, Aug
2	Autumn with unharvested cropland	Sep, Oct, Nov
3	Late autumn after frost and harvest, or winter with no snow	Dec, Jan, Feb
4	Winter with continuous snow on ground	Dec, Jan, Feb
5	Transitional spring with partial green coverage or short annuals	Mar, Apr, May

Table 3.3 AERSURFACE Seasonal Values of Surface Roughness for the NLCD92 21-Land Cover Classification System

Class Number	Class Name	Seasonal Surface Roughness (m)				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.001	0.001	0.001	0.001	0.001
12	Perennial Ice/Snow	0.002	0.002	0.002	0.002	0.002
21	Low Intensity Residential	0.54	0.54	0.50	0.50	0.52
22	High Intensity Residential	1	1	1	1	1
23	Commercial/Industrial/Transportation (Site at airport)	0.1	0.1	0.1	0.1	0.1
	Commercial/Industrial/Transportation (Not at airport)	0.8	0.8	0.8	0.8	0.8
31	Bare Rock/Sand/Clay (Arid Region)	0.05	0.05	0.05	NA	0.05
	Bare Rock/Sand/Clay (Non-arid Region)	0.05	0.05	0.05	0.05	0.05
32	Quarries/Strip Mines/Gravel Pits	0.3	0.3	0.3	0.3	0.3
33	Transitional	0.2	0.2	0.2	0.2	0.2
41	Deciduous Forest	1.3	1.3	0.6	0.5	1
42	Evergreen Forest	1.3	1.3	1.3	1.3	1.3
43	Mixed Forest	1.3	1.3	0.95	0.9	1.15
51	Shrubland (Arid Region)	0.15	0.15	0.15	NA	0.15
	Shrubland (Non-arid Region)	0.3	0.3	0.3	0.15	0.3
61	Orchards/Vineyards/Other	0.3	0.3	0.1	0.5	0.2
71	Grasslands/Herbaceous	0.1	0.1	0.01	0.005	0.05
81	Pasture/Hay	0.15	0.15	0.02	0.01	0.03
82	Row Crops	0.2	0.2	0.02	0.01	0.03
83	Small Grains	0.15	0.15	0.02	0.01	0.03
84	Fallow	0.05	0.05	0.02	0.01	0.02
85	Urban/Recreational Grasses	0.02	0.015	0.01	0.005	0.015
91	Woody Wetlands	0.7	0.7	0.6	0.5	0.7
92	Emergent Herbaceous Wetlands	0.2	0.2	0.2	0.1	0.2

- Noon-Time Albedo:

Noon-time albedo is the fraction of the incoming solar radiation that is reflected from the ground when the sun is directly overhead. Table 3.4 lists typical albedo values as a function of several land use types and season. For practical purposes, the selection of a single value for noon-time albedo, for a land use types and season combination, to process a complete year of meteorological data is desirable. If other conditions are used, the district should review the proposed noon-time albedo values used to pre-process the meteorological data.

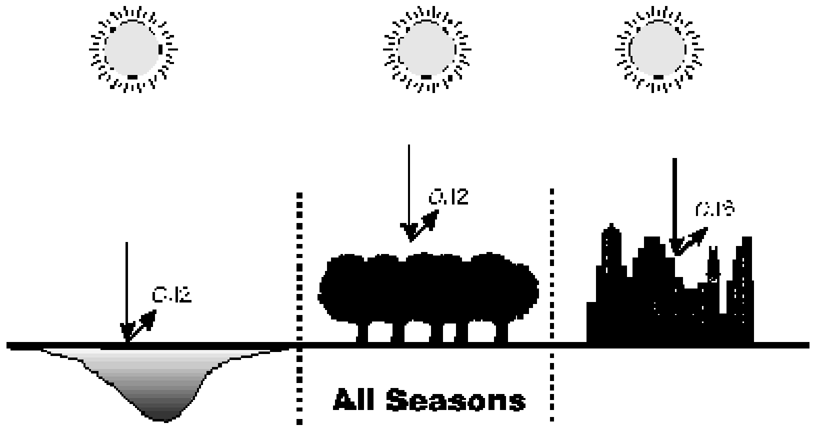

Table 3.4 AERSURFACE Seasonal Values of Albedo for the NLCD92 21-Land Cover Classification System

Class Number	Class Name	Seasonal Albedo Values				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.6	0.6	0.7	0.7	0.6
21	Low Intensity Residential	0.16	0.16	0.18	0.45	0.16
22	High Intensity Residential	0.18	0.18	0.18	0.35	0.18
23	Commercial/Industrial/Transportation (Site at airport)	0.18	0.18	0.18	0.35	0.18
	Commercial/Industrial/Transportation (Not at airport)	0.18	0.18	0.18	0.35	0.18
31	Bare Rock/Sand/Clay (Arid Region)	0.2	0.2	0.2	NA	0.2
	Bare Rock/Sand/Clay (Non-arid Region)	0.2	0.2	0.2	0.6	0.2
32	Quarries/Strip Mines/Gravel Pits	0.2	0.2	0.2	0.6	0.2
33	Transitional	0.18	0.18	0.18	0.45	0.18
41	Deciduous Forest	0.16	0.16	0.17	0.5	0.16
42	Evergreen Forest	0.12	0.12	0.12	0.35	0.12
43	Mixed Forest	0.14	0.14	0.14	0.42	0.14
51	Shrubland (Arid Region)	0.25	0.25	0.25	NA	0.25
	Shrubland (Non-arid Region)	0.18	0.18	0.18	0.5	0.18
61	Orchards/Vineyards/Other	0.18	0.18	0.18	0.5	0.14
71	Grasslands/Herbaceous	0.18	0.18	0.2	0.6	0.18
81	Pasture/Hay	0.2	0.2	0.18	0.6	0.14
82	Row Crops	0.2	0.2	0.18	0.6	0.14
83	Small Grains	0.2	0.2	0.18	0.6	0.14
84	Fallow	0.18	0.18	0.18	0.6	0.18
85	Urban/Recreational Grasses	0.15	0.15	0.18	0.6	0.15
91	Woody Wetlands	0.14	0.14	0.14	0.3	0.14
92	Emergent Herbaceous Wetlands	0.14	0.14	0.14	0.3	0.14

- Bowen Ratio:

The Bowen ratio is a measure of the amount of moisture at the surface. The presence of moisture at the earth's surface alters the energy balance, which in turn alters the sensible heat flux and Monin-Obukhov length. Table 3.5 lists Bowen ratio values as a function of land-use types, seasons and moisture conditions. Bowen ratio values vary depending on the surface wetness. Average moisture conditions would be the usual choice for selecting the Bowen ratio. If other conditions are used the district should review the proposed Bowen ratio values used to pre-process the meteorological data.

Table 3.5 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Average moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Average				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.8	1	1	0.5	0.8
22	High Intensity Residential	1.5	1.5	1.5	0.5	1.5
23	Commercial/Industrial/Transportation (Site at airport)	1.5	1.5	1.5	0.5	1.5
	Commercial/Industrial/Transportation (Not at airport)	1.5	1.5	1.5	0.5	1.5
31	Bare Rock/Sand/Clay (Arid Region)	4	6	6	NA	3
	Bare Rock/Sand/Clay (Non-arid Region)	1.5	1.5	1.5	0.5	1.5
32	Quarries/Strip Mines/Gravel Pits	1.5	1.5	1.5	0.5	1.5
33	Transitional	1	1	1	0.5	1
41	Deciduous Forest	0.3	1	1	0.5	0.7
42	Evergreen Forest	0.3	0.8	0.8	0.5	0.7
43	Mixed Forest	0.3	0.9	0.9	0.5	0.7
51	Shrubland (Arid Region)	4	6	6	NA	3
	Shrubland (Non-arid Region)	1	1.5	1.5	0.5	1
61	Orchards/Vineyards/Other	0.5	0.7	0.7	0.5	0.3
71	Grasslands/Herbaceous	0.8	1	1	0.5	0.4
81	Pasture/Hay	0.5	0.7	0.7	0.5	0.3
82	Row Crops	0.5	0.7	0.7	0.5	0.3
83	Small Grains	0.5	0.7	0.7	0.5	0.3
84	Fallow	0.5	0.7	0.7	0.5	0.3
85	Urban/Recreational Grasses	0.5	0.7	0.7	0.5	0.3
91	Woody Wetlands	0.2	0.2	0.3	0.5	0.2
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1

Table 3.6 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Wet moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Wet				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	0.6	0.6	0.6	0.5	0.6
22	High Intensity Residential	1	1	1	0.5	1
23	Commercial/Industrial/Transportation (Site at airport)	1	1	1	0.5	1
	Commercial/Industrial/Transportation (Not at airport)	1	1	1	0.5	1
31	Bare Rock/Sand/Clay (Arid Region)	1.5	2	2	NA	1
	Bare Rock/Sand/Clay (Non-arid Region)	1	1	1	0.5	1
32	Quarries/Strip Mines/Gravel Pits	1	1	1	0.5	1
33	Transitional	0.7	0.7	0.7	0.5	0.7
41	Deciduous Forest	0.2	0.4	0.4	0.5	0.3
42	Evergreen Forest	0.2	0.3	0.3	0.5	0.3
43	Mixed Forest	0.2	0.35	0.35	0.5	0.3
51	Shrubland (Arid Region)	1.5	2	2	NA	1
	Shrubland (Non-arid Region)	0.8	1	1	0.5	0.8
61	Orchards/Vineyards/Other	0.3	0.4	0.4	0.5	0.2
71	Grasslands/Herbaceous	0.4	0.5	0.5	0.5	0.3
81	Pasture/Hay	0.3	0.4	0.4	0.5	0.2
82	Row Crops	0.3	0.4	0.4	0.5	0.2
83	Small Grains	0.3	0.4	0.4	0.5	0.2
84	Fallow	0.3	0.4	0.4	0.5	0.2
85	Urban/Recreational Grasses	0.3	0.4	0.4	0.5	0.2
91	Woody Wetlands	0.1	0.1	0.1	0.5	0.1
92	Emergent Herbaceous Wetlands	0.1	0.1	0.1	0.5	0.1

Table 3.7 AERSURFACE Seasonal Values of Bowen Ratio for the NLCD92 21-Land Cover Classification System - Dry moisture conditions

Class Number	Class Name	Seasonal Bowen Ratio Values-Dry				
		1	*2*	*3*	*4*	*5*
11	Open Water	0.1	0.1	0.1	0.1	0.1
12	Perennial Ice/Snow	0.5	0.5	0.5	0.5	0.5
21	Low Intensity Residential	2	2.5	2.5	0.5	2
22	High Intensity Residential	3	3	3	0.5	3
23	Commercial/Industrial/Transportation (Site at airport)	3	3	3	0.5	3
	Commercial/Industrial/Transportation (Not at airport)	3	3	3	0.5	3
31	Bare Rock/Sand/Clay (Arid Region)	6	10	10	NA	5
	Bare Rock/Sand/Clay (Non-arid Region)	3	3	3	0.5	3
32	Quarries/Strip Mines/Gravel Pits	3	3	3	0.5	3
33	Transitional	2	2	2	0.5	2
41	Deciduous Forest	0.6	2	2	0.5	1.5
42	Evergreen Forest	0.6	1.5	1.5	0.5	1.5
43	Mixed Forest	0.6	1.75	1.75	0.5	1.5
51	Shrubland (Arid Region)	6	10	10	NA	5
	Shrubland (Non-arid Region)	2.5	3	3	0.5	2.5
61	Orchards/Vineyards/Other	1.5	2	2	0.5	1
71	Grasslands/Herbaceous	2	2	2	0.5	1
81	Pasture/Hay	1.5	2	2	0.5	1
82	Row Crops	1.5	2	2	0.5	1
83	Small Grains	1.5	2	2	0.5	1
84	Fallow	1.5	2	2	0.5	1
85	Urban/Recreational Grasses	1.5	2	2	0.5	1
91	Woody Wetlands	0.2	0.2	0.2	0.5	0.2
92	Emergent Herbaceous Wetlands	0.2	0.2	0.2	0.5	0.2

3.1 Wind Direction Dependent Land Use

AERMET also provides the ability to specify land characteristics for up to 12 different contiguous, non-overlapping wind direction sectors that define unique upwind surface characteristics. The following properties of wind sectors must be true:

- The sectors are defined clockwise as the direction from which the wind is blowing, with north at 360°.
- The sectors must cover the full circle so that the end value of one sector matches the beginning of the next sector.

- The beginning direction is considered part of the sector, while the ending direction is not.

Each wind sector can have a unique albedo, Bowen ratio, and surface roughness. Furthermore, these surface characteristics can be specified annually, seasonally, or monthly to better reflect site conditions.

3.2 Mixed Land Use Types

Study areas may contain several different regions with varying land use. This can be handled by AERMET through the use of wind sector specific characterization, as described in the previous section.

For models such as ISCST3/ISC-PRIME that do not take advantage of sector-specific characterization, the most representative conditions should be applied when land use characteristics are required.

The surface characteristics need to be assessed in a circle with a radius of one to three kilometers from the source. Contact the District to determine the appropriate parameters for meteorological data in accordance with EPA guidance. Data should be chosen for a meteorological data site with surface characteristics similar to those of the area around the source. To prepare the surface data, use the AERSURFACE module of AERMOD or perform a site survey using the standard land uses defined in the AERSURFACE documentation and the default surface roughness length for those land uses.

The surface characteristics are determined by assessing the land use across the monitoring site area and applying the appropriate values to the land characteristic parameters. A weighted average is then computed based on the area of each land use category.

For example: If the area under review is 15% cultivated land, 5% desert shrub land, and 80% Urban, the same weighted percentages would be used to derive a weighted average albedo, Bowen ratio, and surface roughness parameters.

3.3 Seasonal Land Use Characterization

Land use characteristics can be susceptible to seasonal variation. For example, winter conditions can bring increased albedo values due to snow accumulation.

AERMET allows for season-specific values for surface roughness, albedo, and Bowen ratio to be defined. Other models, such as ISCST3/ISC-PRIME, do not support multiple season surface characteristics to be defined. In such a case, the most representative conditions should be applied when land use characteristics are required.

3.4 Standard and Non-Default Surface Characteristics

The generation of local meteorological data files can incorporate site-specific surface characteristics. It should be noted that any local meteorological files generated for air dispersion modeling should provide a clear reasoning for the values used to describe surface characteristics. The district should review any proposed surface characteristics prior to submission of a modeling report.

Appendix B

Modeling and Exposure Assessment Input and Output Data

The following information must be submitted with a risk assessment. It provides the essential requirements for a general assessment. Site-specific scenarios may call for additional information and result in a need for different materials and data to be submitted. It is the responsibility of the submitter to ensure proper completion and analysis of any air dispersion modeling assessment delivered for review. *Consultation with your local air district is strongly recommended.*

1.0 General Information

1.0.1 Submittal Date
1.0.2 Facility/Project Name
1.0.3 Facility/Project Location
1.0.4 Risk Assessor Name

1.1 Hazard Identification

1.1.1 Table of all toxic air contaminants (TAC) emitted by the Facility/Project including:
- CAS number,
- Chemical name(s) – include appropriate common names,
- Physical state as emitted.

1.1.2 Table of carcinogens,
1.1.3 Table of acutely toxic TACs, and
1.1.4 Table of chronically toxic non-carcinogenic TACs.
1.1.5 Table showing the processes and the TACs emitted from each process.

1.2 Exposure Assessment

1.2.1 Air Dispersion Model Options

1.2.1.1 Model Used
- AERMOD - version number,
- ISCST - version number,
- Other Model - Specify name, version number, and reason for use.

1.2.1.2 Regulatory Options Used
- Yes
- No - Provide justification for use of non-regulatory options. Note that use of non-regulatory options requires prior approval from the regulatory agency.

1.2.1.3 Dispersion Coefficients Used, and How they were Determined
- Urban
- Rural

(Urban or Rural conditions can be determined through the use of an Auer Land Use or Population Density analysis.)

1.2.1.4 Coordinate System Used
- UTM Coordinates
- Local Coordinates
- Other

(AERMOD requires UTM coordinates be used to define all model objects. Use of an alternative coordinate system requires advance consultation with the regulatory agency.)

1.2.2 Source Information

1.2.2.1 Source Summaries

Create tables which show the following point, area, volume, line, or flare modeling parameters. Following the tables must be a description of the reasoning for each modeling parameter chosen.

Point Sources Summary

- Source name
- Source location coordinates
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and max hourly and annual emission rate in grams per second.
- Stack heights in meters
- Stack Diameter in meters
- Stack Exit Temperature in degrees K
- Stack Exit Velocity in meters per second
- Stack direction
  - Vertical exhaust direction
  - Horizontal exhaust direction
- Rain Cap Present
  If the stack is either horizontal in orientation or has a rain cap, stack parameters must be adjusted as per guidance.
- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Area Sources Summary

- Source name
- Source location coordinates (Southwest Vertex):
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and emission rate in grams per second-meter^2.
- Exhaust height in meters
- Easterly Dimension in meters
- Northerly Dimension in meters
- Initial Vertical Dimension in meters
- Angle from North in degrees.
- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Volume Sources Summary

- Source name
- Source location coordinates (Center of Source):
  - X (m)
  - Y (m)
- Table showing the names of each TAC modeled and emission rate in grams per second.
- Source height in meters
- Initial Horizontal Dimension in meters
- Initial Vertical Dimension in meters

- Operating Schedule.
  Create tables showing how the normal emission rates vary by source.

Line Sources Summary (CAL3QHCR specific; for step by step guidance according to SMAQMD recommendations, see CAPCOA's CEQA Risk Assessment Guidelines)

- Source name (highway, freeway, or major roadway)
- Roadway compass orientation (in terms of x,y; arbitrary origin of 0,0)
- Location of nearest receptor to source and other receptors as required by local air district
- Calculation averaging time (such as 60 min)
- Surface roughness (cm, from 3 to 400)
- Settling velocity (cm/s)
- Deposition velocity (cm/s)
- Site setting, rural or urban
- Form of traffic volume (recommended: 1 for one hour's data)
- Pollutant (P for PM10)
- Hourly ambient background (0 or as recommended by air district)
- Roadway height indicator (AG for at grade; FL for elevated and filled; BR for bridge; DP for depressed)
- Roadway height (AG is 0)

Other input parameters are required for CAL3QHCR. See CAPCOA's CEQA Risk Assessment Guidelines or contact your local air district.

1.2.2.2 Emissions Profile during Abnormal Operations Start-Up or Shutdown

Create table showing how abnormal emission rates vary by source. Abnormal emission rates include start-up or shutdown.

1.2.2.3 Building Downwash

- Describe whether the stack(s) are located within 5L of a structure that is at least 40% of the stack height (L is the lesser of the height or the maximum projected building width for a structure).
- If it is, then prepare a building downwash analysis using the current version of the Building Profile Input Program – PRIME (BPIP-PRIME) and include results in air dispersion modeling assessment.

1.2.2.4 Scaled Plot Plan

Provide a scaled plot plan, preferably in electronic format, displaying:

- Emission release locations,
- Buildings (On site and neighboring),
- Tanks (On site and neighboring),
- Property boundaries,
- Model receptor locations,
- Sensitive receptors locations,
- Fenceline receptors locations.

1.2.2.5 Sensitive Receptors locations

Describe the location and nature of all nearby sensitive receptors (e.g. residences, schools, hospitals, etc...)

1.2.2.6 Points of Maximum Impact

Demonstrate that the actual point of maximum impact, residential point of maximum impact, and the offsite worker point of maximum impact have been reached.

1.2.3 Terrain Conditions

1.2.3.1 Elevated or complex terrain

Describe whether the modeled area contains elevated or complex terrain, and provide a discussion on the approach used to determine terrain characteristics of the assessment area.

1.2.3.2 Digital Terrain Data

Describe whether the data for digital terrain is:

- CDED 1-degree,
- CDED 15-minute,
- USGS 7.5-minute Ontario dataset, or
- Other, and describe other.

1.2.3.3 Elevation data import

Describe the technique used to determine elevations of receptors and related model entities such as sources.

1.2.4 Meteorological Data

1.2.4.1 Regional Meteorological data

Specify what Regional Meteorological data set was used and note the period of the record.

1.2.4.2 Was a Regional Meteorological Merge data file used?

Specify the Meteorological Data Set Merge file used and summarize land characteristics specified in its processing. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.3 Meteorological data preparation

Specify the Meteorological Data files used and summarize all steps and values used in processing these standard meteorological data files. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.4 Local Meteorological data

Specify the source, reliability, and representativeness of the local meteorological data as well as a discussion of data QA/QC and processing of data. State the time period of the measurements, wind direction dependent land use (if used), and any topographic or shoreline influences. This information should be reviewed by the District prior to submission of a modeling report.

1.2.4.5 Wind Information

The following items should be provided and discussed where applicable:

- Speed and direction distributions (wind roses),
- Topographic and/or obstruction impacts,
- Data completeness,

- Percentage of calms

1.2.4.6 Temperature, clouds, and upper air data

The following items should be provided and discussed where applicable:

- Data completeness,
- Mixing layer heights,
- Diurnal and seasonal variations.

1.2.4.7 Turbulence

The following should be provided and discussed if site specific data is being used:

- Frequency distributions,
- Diurnal and seasonal variations.

1.2.5 Dispersion Model Results

1.2.5.1 Modeling files

The following electronic model input and output files are to be provided:

- BPIP-PRIME - Input and Output files.
- ISCST3/ISC-PRIME or AERMOD - Input and Output files.
- ISCST3/ISC-PRIME or AERMOD - Plot files
- SCREEN3 - Input and Output files if applicable

1.2.5.2 Meteorological Data

The electronic meteorological data files must be provided.

1.2.5.3 Terrain Data

Digital elevation terrain data files must be provided if included in the analysis.

1.2.5.3 Plots and Maps

Include the following:

- Drawing/site plan with modeling coordinate system noted (digital format preferred).
- Plots displaying concentration/deposition results across study area.

1.2.5.5 Emission Summary

An emission summary table must be provided.

1.2.5.6 Discussion

The results overview should include a discussion of the following items, where applicable:

- The use of alternative models,
- The use of any non-default model options,
- Topographic effects on the predictions,
- All predicted concentrations based on the REL based exposure period.

1.3 Toxicity Data

1.3.1 Toxicity Values for Each TAC Emitted

A table must be provided that shows the following data for each TAC emitted:

- The cancer potency factors,
- The acute and chronic RELs,
- The averaging times for the acute RELs,

- The pathways the TAC enters the body, and
- The date these factors were updated.

1.3.2 Target Organ Systems for Each Acute and Non-Carcinogenic Chronic Substance

A table must be provided that shows the target organs and body systems each acute and non-carcinogenic chronic impact.

1.4 Risk Characterization

1.4.1 Points of Maximum Impact

The following points of maximum impact need to be identified:

- The Points of Maximum Impact (PMI),
- The Maximum Exposed Individual - Residential (MEIR), and
- The Maximum Exposed Individual – Worker (MEIW).

At these locations the following data must be provided:

- Locations (UTM coordinates, or Latitude/Longitude coordinates, or other coordinates),
- Cancer risk, acute and chronic hazard indices,
- Sources and pollutants that contribute to risks which exceed the district's cancer risk, or acute, or chronic hazard index significance levels.

1.4.2 Exposure Pathways

Identify each pathways used to determine the cancer risk and chronic hazard indices. Provide all assumptions used for pathways (e.g., the percentage of home-grown vegetables consumed locally, etc…).

1.4.3 Graphical Presentations

Maps must be provided which show the following:

- Locations of sensitive receptors,
- Location of PMI, MEIR, and MEIW for cancer, acute, and non-cancer chronic risks,
- Isopleth lines showing cancer risk, acute, and chronic hazard indices in magnitudes specified by the Air District (e.g., cancer risk starting at 10 per million and increasing by tens per million.)

1.4.4 Guidelines and Software

Specify:

- Describe whether these CAPCOA Guidelines have been applied or other Guidelines were applied,
- The risk assessment software utilized (e.g., Hot Spots Analysis and Reporting Program or HARP),
- If risk assessment software other than HARP is used, then and provide a demonstration that the results will show the same results as HARP,
- Discuss any software used to import model results into HARP.

2.0 Modeling Files

The following files from the air quality dispersion model and risk assessment software should be provided:

Air quality dispersion model (if HARP is not used)

- Input file (*.inp, *.ADI, *.dat)
- Output file (*.out, *.ADO, *.lst)
- Meteorological files

- Plotfiles

Building Downwash Analysis (BPIP) (if HARP is not used)

- Input file
- Output file

Risk assessment software (i.e., HARP):

- Transaction files for the facilities, buildings, and property boundaries (*.tra)
- Transaction files for the source receptors (*.rec)
- Facility database for included facilities building, and property boundaries (*.mdb) as an alternative to the transaction files
- Health factor database (Health.mdb)
- ISC Workbook file with all ISC parameters (*.isc)
- ISC input file generated by HARP when ISC is run (*.inp)
- ISC output file generated by HARP when ISC is run (*.out)
- List of error messages generated by ISC (*.err)
- Plot file generated by ISC (*.plt)
- Representative meteorological data used for the facility air dispersion modeling (*.met)
- Any digital elevation model files (if applicable) (*.dem)
- Average and maximum χ/Q for each source-receptor combination; generated by ISC (*.xoq)
- ISC binary output file (FOR REFINED ACUTE ANALYSIS ONLY); holds χ/Q data for each hour (*.bin)
- Source/receptor file; contains list of sources and receptors for the ISC run; generated by HARP when you set up ISC (*.src)
- Emission Rate files (if changes were made to database) (*.ems)
- Site-specific parameters used for all receptor risk modeling (*.sit)
- (Screening) Adjustment factor files (IF SCREEN MET IS USED) (*.adj)
- Point estimate risk reports generated by HARP; this file is updated automatically each time you perform one of the point estimate risk analysis functions ((e.g., acute, chronic, cancer, derived (adjusted). Etc.)) (*.rsk)
- Database for Census (population) file (census.mdb)
- Map file used to overlay facility and receptors (*.map)
- HARP Exception Report (ExceptionReport.txt)
- Risk result text files for key receptors (STANDARD REPORT SET) (*.txt)
- STOCHASTIC Raw sample file (*.csv)
- STOCHASTIC Sample file (*.spl)
- STOCHASTIC Summary report (*.txt)
- Equivalent files for software other than HARP

CEQA
Air Quality Handbook

A GUIDE FOR ASSESSING
THE AIR QUALITY IMPACTS
FOR PROJECTS SUBJECT TO CEQA REVIEW

April 2012

SLO COUNTY apcd

Air Pollution Control District
San Luis Obispo County

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Tables

Figures

LIST OF ACRONYMS

ACM	Asbestos Containing Material
ADT	Average Daily Trips
APCD	San Luis Obispo County Air Pollution Control District
APS	Auxiliary Power System
ARB	California Air Resources Board
ATCM	Air Toxics Control Measure
BACT	Best Available Control Technology for Construction Equipment
CAAA	1990 Clean Air Act Amendments
CAMP	Construction Activity Management Plan
CAP	Clean Air Plan for San Luis Obispo County
CAPCOA	California Air Pollution Control Officers Association
CEQA	California Environmental Quality Act
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon Dioxide
DEIR	Draft Environmental Impact Report
DOC	Diesel Oxidation Catalyst
DPM	Diesel Particulate Matter
EIR	Environmental Impact Report
EPA	United States Environmental Protection Agency
GHG	Greenhouse Gases
HRA	Health Risk Assessment
ITE	Institute of Transportation Engineers
LNG	Liquid Natural Gas
NESHAP	National Emission Standard for Hazardous Air Pollutants
NOA	Naturally Occurring Asbestos
NOP	Notice of Preparation
NO_x	Oxides of Nitrogen
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter (less than 2.5 µm)
PM_{10}	Particulate Matter (less than 10 µm)
ROG	Reactive Organic Gases
SLO	San Luis Obispo
TAC	Toxic Air Contaminant
VDECS	Verified Diesel Emission Control Systems
VMT	Vehicle Miles Traveled

GLOSSARY

Climate Change: Climate change refers to long-term changes in temperature, precipitation, wind patterns, and other elements of the earth's climate system. An ever-increasing body of scientific research attributes these climatological changes to greenhouse gases (GHGs), particularly those generated from the human production and use of fossil fuels.

Diverted Trips: Diverted linked trips, as defined by Institute of Transportation Engineers (ITE), are attracted from the traffic volume on a roadway within the vicinity of the generator but require a diversion from that roadway to another roadway to gain access to the site.

Fugitive Dust: Small particles which are entrained and suspended into the air by the wind or external disturbances. Fugitive dust typically originates over an area and not a specific point. Typical sources include unpaved or paved roads, construction sites, mining operations, disturbed soil and tilled agricultural areas.

Greenhouse Gas: The emissions that contribute to the climate change effect are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFC), chlorofluorocarbons (CFC) and sulfur hexafluoride (F6S).

Ozone Precursors: Gaseous compounds needed to form ozone by the process of photochemistry. Photochemical air pollution (primarily ozone) is produced by the atmospheric reaction of organic substances, such as reactive organic gases (ROG) and nitrogen dioxide (NO_2) under the influence of sunlight.

$$NO_2 + ROG + Sunlight => O_3$$

During the summer, in areas with high emissions and high ozone concentrations, ozone concentrations are very dependent on the amount of solar radiation. Ozone levels typically peak in the late afternoon, at the end of the longest period of daily solar radiation. After the sun goes down, the chemical reaction between nitrous oxide and ozone begins to dominate and ozone usually decreases.

$$O_3 + NO => NO_2 + O_2$$

In some remote rural locations away from emission sources, ozone concentrations can remain high overnight because there are no NO sources to react with the existing ozone.
Ozone precursors are typically considered to be the combination of ROG + NO_x.

Particulate Matter: Small particles that become airborne and have the potential to cause adverse health impacts. There are three general size components: 1) PM or Total Suspended Particulate (TSP) which includes all airborne particles regardless of size or source; 2) PM_{10} which includes airborne particles 10µm in size and smaller; and 3) $PM_{2.5}$ or fine airborne particles 2.5µm and smaller.

Primary Trips: Trips made for the specific purpose of visiting the proposed facility.

Passby Trip: Trips made as an intermediate stop on the way from an origin to a destination without a route diversion.

Sensitive Receptors: Sensitive receptors are people that have an increased sensitivity to air pollution or environmental contaminants. Sensitive receptor locations include schools, parks and playgrounds, day care centers, nursing homes, hospitals, and residential dwelling unit(s). The location of sensitive receptors is needed to assess toxic impacts on public health.

Smart Growth: Smart or strategic growth is an urban planning and transportation theory that concentrates growth in the center of a city to avoid urban sprawl; and advocates compact, transit-oriented, walkable, bicycle-friendly land use, including neighborhood schools, complete streets, and mixed-use development with a range of housing choices.

Verified Diesel Emission Control Strategy: Diesel vehicle or equipment exhaust retrofits that have been verified by the California Air Resources Board (ARB) that provide specified diesel particulate emission reductions when implemented in compliance with the ARB executive order for the device (www.arb.ca.gov/diesel/verdev/verdev.htm).

CEQA
Air Quality Handbook

GUIDE FOR ASSESSING THE AIR QUALITY IMPACTS FOR PROJECTS SUBJECT TO CEQA REVIEW

The purpose of this document is to assist lead agencies, planning consultants, and project proponents in assessing the potential air quality impacts from residential, commercial and industrial development. It is designed to provide uniform procedures for preparing the air quality analysis section of environmental documents for projects subject to the California Environmental Quality Act (CEQA). These guidelines define the criteria used by the San Luis Obispo County Air Pollution Control District (APCD or Air District) to determine when an air quality analysis is necessary, the type of analysis that should be performed, the significance of the impacts predicted by the analysis, and the mitigation measures needed to reduce the overall air quality impacts. The use of this document will simplify the process of evaluating and mitigating the potential air quality impacts from new development in San Luis Obispo County.

For further information on any of the topics covered in this handbook, review the APCD's website at www.slocleanair.org or contact us directly at (805) 781-5912.

1 PROJECTS REQUIRING AIR QUALITY REVIEW AND ANALYSIS

The Air District has permit authority over many "direct" sources of air contaminants, such as power plants, gasoline stations, dry cleaners and refineries. Indirect sources are contributors to air pollution and include facilities and land uses which may not emit a significant amount of pollution themselves, but are responsible for indirect emissions, such as:

- Motor vehicle trips attracted to or generated by the land use;
- On-site combustion of natural gas, propane and wood for heating;
- Architectural coatings and consumer products; and,
- Landscape maintenance.

Emission impacts from both direct and indirect sources are typically identified and, if needed mitigated through the land use planning process under the guidelines and statutes of CEQA.

1.1 ROLE OF THE SLO COUNTY APCD

Under CEQA, the SLO County APCD may act as a **lead, responsible or commenting agency**, reviewing and commenting on projects which have the potential to cause adverse impacts to air quality. The CEQA statutes and guidelines require lead agencies to seek comments from each responsible agency and any public agency that have jurisdiction by law over resources that may be affected by a proposed project (CEQA 21153 and 15366). For many development proposals, this typically involves projects where vehicle trip generation is high enough to cause or contribute to local emission levels capable of hindering the APCD's efforts to attain and maintain health-based air quality standards. It is in this context that local jurisdictions and planning bodies can make critical decisions that affect their future environment and that of neighboring communities as well.

Offshore activities within State waters, such as oil drilling and production, harbor dredging and cable installation are also subject to CEQA review and possible APCD permits depending on the nature of the activity.

1.2 PROJECTS SUBJECT TO AIR QUALITY ANALYSIS

In general, any proposed project with **short-term construction** emissions or **long-term operational** emissions that may exceed an APCD threshold of significance, as identified in this Handbook, should be submitted to the SLO County APCD for review. If needed, the APCD will assist in refining impact evaluations and or appropriate mitigation measures. The project will be evaluated to determine the potential for significant air quality impacts, with further analysis or mitigation recommended if appropriate. Types of projects which generally fall into this category include:

- Discretionary Permits;
- Tract Maps;
- Development Plans;
- Site Plans;
- Area Plans;
- Specific Plans;
- Local Coastal Plans;
- General Plan Updates and Amendments;
- Large residential developments;
- Large commercial or industrial developments; and
- Remediation projects.

The environmental documents associated with these types of projects and reviewed by the APCD include Initial Studies, Notices of Preparation (NOP), Negative Declarations, and Environmental Impact Reports (EIR), and other environmental documents prepared pursuant to CEQA and NEPA.

1.3 PROJECT INFORMATION NEEDED FOR SLO COUNTY APCD REVIEW

Early consultation with the APCD can ensure the environmental document adequately addresses air quality issues. In order to facilitate our review of the proposed project, the following information should be provided:

- Complete and accurate project description;
- Emission calculations for both construction and operational phase emissions;
- Relevant environmental documents, including draft EIRs, Initial Studies, Negative Declarations, etc;
- Other technical analyses that relate to air quality, including but not limited to traffic analyses, growth impact projections, land use elements, maps, health risk assessments, sensitive receptor locations etc; and,
- Mitigation Monitoring Program, if applicable.

1.4 OPERATIONAL SCREENING CRITERIA FOR PROJECT IMPACTS

General screening criteria used by the SLO County APCD to determine the type and scope of projects requiring an air quality assessment, and/or mitigation, is presented in Table 1-1. These criteria are based on project size in an urban setting and are designed to identify those projects with the potential to exceed the APCD's significance thresholds. Operational impacts are focused primarily on the indirect emissions (i.e., motor vehicles) associated with residential, commercial and industrial development.

Table 1-1 is based on ozone precursor and greenhouse gas (GHG) emissions and is not comprehensive. It should be used for general guidance only. This table is not applicable for projects that involve heavy-duty diesel activity and/or fugitive dust emissions. A more refined analysis of air quality impacts specific to a given project is necessary for projects that exceed the screening criteria below or are within ten percent (10%) of exceeding the screening criteria.

Table 1-1: Operational Screening Criteria for Project Air Quality Analysis(1, 2)

Land Use	Unit of Measure	Size of Urban/(Rural) Project Expected to Exceed the APCD Annual GHG Bright Line Threshold (3) of:	Size of Urban/(Rural) Project Expected to Exceed the APCD Daily Ozone Precursor Significance Threshold (4) of:
		1150 MT CO2e/year from Operational & Amortized Construction Impacts	25 lbs ROG+NOx/Day from Operational Impacts
COMMERCIAL			
Bank (with Drive-Through)		25	17
General Office Building		70	91
Government (Civic Center)		37	38
Government Office Building		26	21
Hospital	1,000 SF	31	50
Medical Office Building		[illegible]	36
Office Park		[illegible]	85
Pharmacy/Drugstore w/o Drive Thru		[illegible]	24
Pharmacy/Drugstore with Drive Thru		[illegible]	25
Research & Development		93	114

This table has been updated, July 2014. The revised version can be located on our web site by clicking **HERE**.

EDUCATIONAL [5]			
Day Care Center	1,000 SF	39	26
Elementary School		69	62
High School		62	61
Junior High School		72	65
Library		24	23
Place of Worship		77	44
Junior College (2yr)	Students	1070	1032
University/College (4yr)		464	487
INDUSTRIAL [6]			
General Heavy Industry	1,000 SF	53	311
General Light Industry		23	103
Industrial Park		36	113
Manufacturing		44	168
Refrigerated Warehouse-No Rail		47	237
Refrigerated Warehouse-Rail		50	324
Unrefrigerated Warehouse-No Rail		51	237
Unrefrigerated Warehouse-Rail		51	324
RECREATIONAL			
Fast Food Restaurant w/o Drive Thru	1,000 SF	2.9	2.6
Fast Food Restaurant with Drive Thru		5.7	3.5
Health Club		42	46
High Turnover (Sit Down Restaurant)		13.7	13.2
Movie Theater (No Matinee)		20	21
Quality Restaurant		18	21
Racquet Club		44	48
Recreational Swimming Pool		42	41
Arena	Acres	178	159
City Park		103	786
Golf Course		138	241
Hotel	Rooms	85	126
Motel		79	142
RESIDENTIAL			
Apartment High Rise	Dwelling Units	113	94
Apartment Low Rise		109 / (74)	94 / (71)
Apartment Mid Rise		112	94
Condo/Townhouse General		103 / (72)	93 / (69)
Condo/Townhouse High Rise		104	93
Congregate Care (Assisted Living)		196	157
Mobile Home Park		124	112
Retirement Community		169	- [7]
Single Family Housing		70 / (49)	68 / (50)
RETAIL			
Auto Care Center	1,000 SF	33	32
Convenience Market (24 hour)		5.5	3.3
Convenience Market w/ Gas Pumps		5.7	2.3
Discount Club		37	34
Electronic Superstore		50	48
Free Standing Discount Store		29	25

Free Standing Discount Superstore		30	27
Hardware/Paint Store		28	22
Home Improvement Superstore		46	36
Regional Shopping Center		36	31
Strip Mall		40	38
Supermarket		17.2	12.5
Gasoline/Service Station	Pumps	32	10

1. The screening levels in this table were created using CalEEMod version 2011.1.1 with default San Luis Obispo County urban settings; some rural setting results are also included and are denoted in parentheses. If the project is not represented well by an urban settings, (e.g. urban fringe development where urban trip lengths are not representative), then the project impacts need to be specifically evaluated in CalEEMod using project specific information; modeling results, substantiated assumptions, and CalEEMod files need to be presented to the APCD for review and approval.
2. This screening table is based on annual GHG emissions and daily ozone precursor emissions, and is not comprehensive. It should be used for general guidance only. This table is not applicable for projects that involve substantial heavy-duty diesel activity and/or fugitive dust emissions. A more refined analysis of air quality impacts specific to a given project is recommended for projects exceeding the screening criteria values or that are within 10% of the screening criteria values in this table.
3. Use of this table does not preclude lead agencies from complying with Section 15064.4 of the California Environmental Quality Act ("CEQA") Guidelines which requires that "a lead agency should make a good-faith effort… to describe, calculate or estimate the amount of greenhouse gas emissions resulting from a project." If there is substantial evidence that the possible effects of a particular project are still cumulatively considerable, notwithstanding compliance with the screening levels in this table, a refined emissions quantification and analysis should be conducted.
4. For ozone precursor evaluations the APCD considers CalEEMod winter scenario simulations worst case because winter emissions are typically higher than its summer emissions.
5. All projects involving the purchase of a school site, or construction of a new elementary or secondary school, must be referred to the APCD for review and comment. (Pub. Resources Code Section 21151.8, Subd. (a)(2)).
6. The size of projects expected to exceed the GHG Threshold of significance for Industrial Land Uses is much smaller than a project that would exceed the Ozone Precursor Threshold as a result of a CalEEMod.2011.1.1 model error in the calculations for industrial projects. This error is scheduled to be corrected in the next CalEEMod model update.
7. Currently there is a CalEEMod model error for the retirement community category. If you are evaluating a project in this category, use the comparable Mobile Home Park category for screening.

1.5 PREPARING THE AIR QUALITY ANALYSIS SECTION FOR CEQA DOCUMENTS

As shown in Table 1-1, use of a simple screening analysis in a Negative Declaration, or emissions calculations and appropriate mitigation measures in a Mitigated Negative Declaration may be all that is necessary for many smaller urban projects. For larger projects requiring the preparation of an EIR, a more comprehensive air quality analysis is often needed. Such an analysis should address both construction phase and operational phase impacts of the project and include the following information:

a. A description of existing air quality and emissions in the impact area, including the attainment status of SLO County relative to State and Federal air quality standards and any existing regulatory restrictions to development. The most recent Clean Air Plan should be consulted for applicable information.

b. A thorough emissions analysis should be performed on all relevant emission sources, using emission factors from the EPA document AP-42 "Compilation of Air Pollutant Emission Factors", the latest approved version of California Emission Estimator Model (CalEEMod), EMFAC, OFF-ROAD or other approved emission calculator tools. The emissions analysis should include calculations for estimated emissions of all criteria air pollutants and toxic air contaminants released from the anticipated land use mix on a quarterly and yearly basis. Documentation of emission factors and all assumptions (i.e. anticipated land uses, average daily trip rate from trip generation studies, etc.) should be provided in an appendix to the EIR.

c. The EIR should include a range of alternatives to the proposed project that could effectively minimize air quality impacts, if feasible. A thorough emissions analysis should be conducted for each of the proposed alternatives identified. The EIR author should contact the SLO County APCD if additional information and guidance is required. All calculations and assumptions used should be fully documented in an appendix to the EIR.

d. Assembly Bill 32, the California Global Warming Solution Act of 2006 and California Governor Schwarzenegger Executive Order S-3-05 (June 1, 2005), both require reductions of greenhouse gases in the State of California. Senate Bill 97 required the Office of Planning and Research to develop and the Natural Resources Agency to adopt Amendments to the CEQA Guidelines for greenhouse gas emissions. Based on these guidelines, greenhouse gas emissions should be evaluated in the EIR along with appropriate mitigation.

e. If a project has the potential to emit toxic or hazardous air pollutants including diesel exhaust, and is located in close proximity to sensitive receptors, impacts may be considered significant due to increased cancer risk for the affected population, even at very low levels of emissions. Such projects may be required to prepare a risk assessment to determine the potential level of risk associated with their operations. The SLO County APCD should be consulted on any project with the potential to emit toxic or hazardous air pollutants.

   Pursuant to the requirements of California Health and Safety Code Section 42301.6 (AB 3205) and Public Resources Code Section 21151.8, subd. (a)(2), any new school or proposed industrial or commercial project site located within 1000 feet of a school must be referred to the SLO County APCD for review. Further details on requirements for projects in this category are presented in Appendix A.

f. The ARB has determined that emissions from sources such as roadways and distribution centers and to a lesser extent gas stations, certain dry cleaners, marine ports and airports as well as refineries can lead to unacceptably high health risk from diesel particulate matter and other toxic air contaminants. The APCD has established a CEQA health risk threshold of **89 in-a-million** for sources which are not otherwise directly regulated; this value represents the health risk caused by ambient concentration of toxics in San Luis Obispo County. A list of potential sources and recommended buffer distances can be found in Section 4.2 of the Handbook. If the proposed project is located in close proximity to any of the listed sources a health risk screening and/or assessment should be performed to assess risk to potential residence of the development.

g. A consistency analysis with the Clean Air Plan is required for a Program Level environmental review, and may be necessary for a Project Level environmental review, depending on the project being considered. Details on conducting a consistency analysis with the Clean Air Plan can be found in Section 3.2.

h. A cumulative impact analysis should be performed to evaluate the combined air quality impacts of this project and impacts from existing and proposed future development in the area. This should encompass all planned construction activities within one mile of the project.

i. The data analyses requested above should address local and regional impacts with respect to maintaining applicable air quality standards at build out. Authors should consult the SLO County APCD to determine if a modeling analysis should be performed and included in the EIR.

j. Temporary construction impacts, such as fugitive dust and combustion emissions from construction and grading activities, should be quantified and mitigation measures proposed. In addition, naturally occurring asbestos may exist at the site. A geological survey is required for the site if it is located in the APCD identified candidate naturally occurring asbestos area. If naturally occurring asbestos is found, the EIR should indicate that a plan will be developed to comply with the requirements listed in the Air Resources Board's Asbestos ATCM for Construction, Grading, Quarrying, and Surface Mining Operations. If naturally occurring asbestos is not present at the site an exemption request will need to be filed with the APCD.

k. Mitigation measures should be recommended, as appropriate, following the guidelines presented in Sections 2.3, 2.4 and 3.7 of this document.

2 ASSESSING AND MITIGATING CONSTRUCTION IMPACTS

Use of heavy equipment and earth moving operations during project construction can generate fugitive dust and engine combustion emissions that may have substantial temporary impacts on local air quality and climate change. Fugitive dust of concern is particulate matter that is less than ten microns in size (PM_{10}) and is not emitted from definable point sources such as industrial smokestacks. Sources include open fields, roadways, storage piles, earthwork, etc. Fugitive dust emissions results from land clearing, demolition, ground excavation, cut and fill operations and equipment traffic over temporary roads at the construction site.

Heavy-duty construction equipment is usually diesel powered. In July 1999, the ARB listed the particulate fraction of diesel exhaust as a toxic air contaminant, identifying both chronic and carcinogenic public health risks. Combustion emissions, such as nitrogen oxides (NO_x), reactive organic gases (ROG), greenhouse gases (GHG) and diesel particulate matter (diesel PM), are most significant when using large, diesel-fueled scrapers, loaders, bulldozers, haul trucks, compressors, generators and other heavy equipment. Emissions from both fugitive dust and combustion sources can vary substantially from day-to-day depending on the level of activity, the specific type of operation, moisture content of soil, use of dust suppressants and the prevailing weather conditions.

Depending on the construction site location and proximity to sensitive receptors, a project that generates high levels of construction emissions, including diesel PM, may be required to perform a health risk assessment to evaluate short-term exposures to high pollutant concentrations and, if necessary, to implement mitigations measures. Mitigation requirements and the need for further analysis will be determined on a case-by-case basis, based upon emission levels and the potential risk for human exposure and effects. Diesel PM emissions may therefore be a factor in whether Best Available Control Technology (BACT) for construction equipment will be needed, even when emissions of criteria pollutants are below the Air District's significance thresholds.

The following information will assist the user in evaluating the fugitive dust and combustion emissions from a project and in proposing appropriate mitigation measures to reduce these impacts to a level of insignificance.

2.1 CONSTRUCTION SIGNIFICANCE CRITERIA

Construction emissions must be calculated for all development projects likely to exceed the construction emissions threshold, or if the project is subject to the special conditions defined in Section 2.1.1. Details on how to conduct emission calculations are discussed in Section 2.2 below. Once the emissions have been calculated, they should then be compared to the APCD construction phase significance thresholds.

Comparison to APCD Construction Significance Thresholds
The threshold criteria established by the SLO County APCD to determine the significance and appropriate mitigation level for a project's **short-term construction** emissions are presented in Table 2-1.

Most of the **short-term construction mitigation strategies** in Sections 2.3 and 2.4 focus on reducing fugitive dust emissions from work sites and haul vehicles, reducing combustion emissions from construction equipment, reducing asbestos (e.g., NOA) and scheduling construction activities to protect public health.

Table 2-1 provides general thresholds for determining the significance of impacts for total emissions expected from a project's construction activities. The discussion following the table provides a more detailed explanation of the thresholds. The Air District has discretion to require mitigation for projects that will not exceed the mitigation thresholds if those projects will result in special impacts, such as the release of diesel PM emissions or asbestos near sensitive receptors.

Table 2-1: Thresholds of Significance for Construction Operations

Pollutant	Threshold[1]		
	Daily	Quarterly Tier 1	Quarterly Tier 2
ROG + NO_x (combined)	137 lbs	2.5 tons	6.3 tons
Diesel Particulate Matter (DPM)	7 lbs	0.13 tons	0.32 tons
Fugitive Particulate Matter (PM_{10}), Dust[2]		2.5 tons	
Greenhouse Gases (CO_2, CH_4, N20, HFC, CFC, F6S)	Amortized and Combined with Operational Emissions (See Below)		

1. Daily and quarterly emission thresholds are based on the California Health & Safety Code and the CARB Carl Moyer Guidelines.
2. Any project with a grading area greater than 4.0 acres of worked area can exceed the 2.5 ton PM_{10} quarterly threshold.

Mitigation of construction activities is required when the emission thresholds are equaled or exceeded by fugitive and/or combustion emissions:

ROG and NOx Emissions

- **Daily:** For construction projects expected to be completed in less than one quarter (90 days), exceedance of the 137 lb/day threshold requires Standard Mitigation Measures;
- **Quarterly – Tier 1:** For construction projects lasting more than one quarter, exceedance of the 2.5 ton/qtr threshold requires Standard Mitigation Measures and Best Available Control Technology (BACT) for construction equipment. If implementation of the Standard Mitigation and BACT measures cannot bring the project below the threshold, off-site mitigation may be necessary; and,
- **Quarterly – Tier 2:** For construction projects lasting more than one quarter, exceedance of the 6.3 ton/qtr threshold requires Standard Mitigation Measures, BACT, implementation of a Construction Activity Management Plan (CAMP), and off-site mitigation.

Diesel Particulate Matter (DPM) Emissions

- **Daily:** For construction projects expected to be completed in less than one quarter, exceedance of the 7 lb/day threshold requires Standard Mitigation Measures;
- **Quarterly - Tier 1:** For construction projects lasting more than one quarter, exceedance of the 0.13 tons/quarter threshold requires Standard Mitigation Measures, BACT for construction equipment; and,
- **Quarterly - Tier 2:** For construction projects lasting more than one quarter, exceedance of the 0.32 ton/qtr threshold requires Standard Mitigation Measures, BACT, implementation of a CAMP, and off-site mitigation.

Fugitive Particulate Matter (PM10), Dust Emissions

- **Quarterly:** Exceedance of the 2.5 ton/qtr threshold requires Fugitive PM_{10} Mitigation Measures and may require the implementation of a CAMP.

Greenhouse Gas Emissions

- GHGs from construction projects must be quantified and amortized over the life of the project. The amortized construction emissions must be added to the annual average operational emissions and then compared to the operational thresholds in Section 3.5.1—Significance Thresholds for Project-Level Operational Emissions. To amortize the emissions over the life of the project, calculate the total greenhouse gas emissions for the construction activities, divide it by the project life (i.e., 50 years for residential projects and 25 years for commercial projects) then add that number to the annual operational phase GHG emissions.

2.1.1 Special Conditions for Construction Activity

In addition to the construction air quality thresholds defined above, there are a number of special conditions, local regulations or state / federal rules that apply to construction activities. These conditions must be addressed in proposed construction activity.

Sensitive Receptors

The proximity of sensitive individuals (receptors) to a construction site constitutes a special condition and may require a more comprehensive evaluation of toxic diesel PM impacts and if deemed necessary by the SLO County APCD, more aggressive implementation of mitigation measures than described below in the diesel idling section. Areas were sensitive receptors are most likely to spend time include schools, parks and playgrounds, day care centers, nursing homes, hospitals, and residential dwelling unit(s). Sensitive receptor locations for a project need to be identified during the CEQA review process and mitigation to minimize toxic diesel PM impacts need to be defined. The types of construction projects that typically require a more comprehensive evaluation include large-scale, long-term projects that occur within 1,000 feet of a sensitive receptor location(s).

Diesel Idling Restrictions for Construction Phases

The APCD recognizes the public health risk reductions that can be realized by idle limitations for both on and off-road equipment. The following idle restricting measures are required for the construction phase of projects:

a. Idling Restrictions Near Sensitive Receptors for Both On and off-Road Equipment
   1. Staging and queuing areas shall not be located within 1,000 feet of sensitive receptors;
   2. Diesel idling within 1,000 feet of sensitive receptors is not permitted;
   3. Use of alternative fueled equipment is recommended whenever possible; and,
   4. Signs that specify the no idling requirements must be posted and enforced at the construction site.

b. Idling Restrictions for On-road Vehicles

   Section 2485 of Title 13, the California Code of Regulations limits diesel-fueled commercial motor vehicles that operate in the State of California with gross vehicular weight ratings of greater than 10,000 pounds and licensed for operation on highways. It applies to California and non-California based vehicles. In general, the regulation specifies that drivers of said vehicles:
   1. Shall not idle the vehicle's primary diesel engine for greater than 5 minutes at any location, except as noted in Subsection (d) of the regulation; and,
   2. Shall not operate a diesel-fueled auxiliary power system (APS) to power a heater, air conditioner, or any ancillary equipment on that vehicle during sleeping or resting in a sleeper berth for greater than 5.0 minutes at any location when within 100 feet of a restricted area, except as noted in Subsection (d) of the regulation.

   Signs must be posted in the designated queuing areas and job sites to remind drivers of the 5 minute idling limit. The specific requirements and exceptions in the regulation can be reviewed at the following web site: www.arb.ca.gov/msprog/truck-idling/2485.pdf.

c. Idling Restrictions for off-Road Equipment

   Off-road diesel equipment shall comply with the 5 minute idling restriction identified in Section 2449(d)(3) of the California Air Resources Board's In-Use off-Road Diesel regulation: www.arb.ca.gov/regact/2007/ordiesl07/frooal.pdf.

   Signs shall be posted in the designated queuing areas and job sites to remind off-road equipment operators of the 5 minute idling limit.

Naturally Occurring Asbestos

Naturally Occurring Asbestos (NOA) has been identified as a toxic air contaminant by the California Air Resources Board (ARB). Under the ARB Air Toxics Control Measure (ATCM) for Construction, Grading, Quarrying, and Surface Mining Operations, prior to any grading activities a geologic evaluation should be conducted to determine if NOA is present within the area that will be disturbed. If NOA is not present, an exemption request must be filed with the District. If NOA is found at the site, the applicant must comply with all requirements outlined in the Asbestos ATCM. This may include development of an Asbestos Dust Mitigation Plan and an Asbestos Health and Safety Program for approval by the APCD. Technical Appendix 4.4 of this Handbook includes a map of zones throughout SLO County where NOA has been found and geological evaluation is required prior to any grading. More information on NOA can be found at http://www.slocleanair.org/business/asbestos.asp.

Asbestos Material in Demolition

Demolition activities can have potential negative air quality impacts, including issues surrounding proper handling, demolition, and disposal of asbestos containing material (ACM). Asbestos containing materials could be encountered during demolition or remodeling of existing buildings. Asbestos can also be found in utility pipes/pipelines (transite pipes or insulation on pipes). If utility pipelines are scheduled for removal or relocation or a building(s) is proposed to be removed or renovated, various regulatory requirements may apply, including the requirements stipulated in the National Emission Standard for Hazardous Air Pollutants (40CFR61, Subpart M - asbestos NESHAP). These requirements include but are not limited to: 1) notification to the APCD, 2) an asbestos survey conducted by a Certified Asbestos Inspector, and, 3) applicable removal and disposal requirements of identified ACM. More information on Asbestos can be found at http://www.slocleanair.org/business/asbestos.php.

Developmental Burning

APCD regulations prohibit developmental burning of vegetative material within SLO County.

Permits

Portable equipment and engines 50 horsepower (hp) or greater, used during construction activities will require California statewide portable equipment registration (issued by the ARB) or an Air District permit. The following list is provided as a guide to equipment and operations that may have permitting requirements, but should not be viewed as exclusive:

- Power screens, conveyors, diesel engines, and/or crushers;
- Portable generators and equipment with engines that are 50 hp or greater;
- Internal combustion engines;
- Unconfined abrasive blasting operations;
- Concrete batch plants;
- Rock and pavement crushing;
- Tub grinders; and,
- Trommel screens.

2.2 METHODS FOR CALCULATING CONSTRUCTION EMISSIONS

In calculating emissions for construction operations (NO_x, ROG, DPM, GHG and fugitive PM), specific information about each activity and phase of the construction project is needed. Several methods are described below, each of which requires increasingly detailed information to produce more accurate results.

All assumptions, estimates, and calculation methods must be provided for SLO County APCD review. Calculation of combustion and fugitive dust emissions from construction activities should include peak daily, quarterly, annual, and total construction phase emissions of NO_x, ROG, diesel PM, GHG and fugitive PM. Both the duration of the construction activities and schedule of phases are required in the evaluation. When using CalEEMod or a spreadsheet to model construction emissions, the **electronic** project file (not a pdf) needs to be submitted to the SLO County APCD for review along with a summary table showing all emissions. The electronic file(s) need to be submitted to the APCD for review and shall include specific and summary emission reports, a detailed explanation of any deviations from CalEEMod defaults, and a detailed description of assumptions used for the emission calculations.

It may be necessary to calculate the project's construction impacts without knowing the exact fleet of construction equipment involved in the project. Table 2-2 contains screening construction emission rates based on the volume of soil moved and the area disturbed. This table should only be used when no other project information is available.

Table 2-2: Screening Emission Rates for Construction Operations

Pollutant	Grams/Cubic Yard of Material Moved	Lbs/Cubic Yard of Material Moved
Diesel PM	2.2	0.0049
Reactive Organic Gases (ROG)	9.2	0.0203
Oxides of Nitrogen (NO_x)	42.4	0.0935
Fugitive Dust (PM_{10})	0.75 tons/acre/month of construction activity (assuming 22 days of operation per month)	

ROG, NO_x, DPM Source: Bay Area Air Quality Management District CEQA Guidelines, December 1999, Table 7
PM_{10} Source: EPA-AP-42 (January 1995) and Index of Methodologies by Major Category Section 7.7 Building Construction Dust, California Air Resources Board, August 1997

The next level of specificity in defining project construction emissions involves the use of CalEEMod computer model. This model contains emission factors for a variety of construction equipment. It will automatically generate default values for the parameters listed below.

- Construction fleet;
- Construction phase duration (user must specify the start and end dates for each phase);
- Daily disturbed acreage;
- Fugitive dust emission rate;
- Asphalt paving (if applicable);
- Construction workers' trips;
- Equipment fleet mix for various phases of construction:
- Construction vendors' trips; and,
- Architectural coating emissions.

CalEEMod will not automatically calculate off-site hauling trips and associated emissions. If soil or demolition materials will need to be hauled off-site or materials will be imported, cubic yards of material and the number of truck trips will need to be entered into the model. The trip length associated with hauling also needs to be entered into the model along with a detailed explanation of the trip length. Specific truck emission factors for the hauling fleet should to be included in the simulation. If the specific fleet is unknown at time of modeling, then a defensible worst case set of hauling fleet emission factors shall be used. This hauling component is an important step and is often overlooked resulting in under estimation of emissions.

If more detailed information regarding the construction phase of the project is known, the construction phases and default values can be modified in this step to more accurately reflect the anticipated emissions from the project.

A component of CalEEMod, the construction calculator, allows project specific equipment data to be used to calculate emissions. The use of the construction calculator is recommended for those projects that are in the final phase of planning when the actual fleet mix and construction schedule is defined to validate previous emission estimates and finalize mitigation measures. The following variables can be defined for each piece of construction equipment:

- Equipment type;
- Quality of equipment used;
- Horsepower rating;
- Load factor;
- Usage (hours/day);
- Engine model year;
- Engine deterioration (years and hours since last rebuild); and,
- Exhaust after-treatment devices such as VDEC (verified diesel emission control devices).

More detailed information about CalEEMod can be found at www.caleemod.com

2.3 ROG, NO_X, PM AND GHG COMBUSTION MITIGATION MEASURES

Construction mitigation measures are designed to reduce emissions (ROG, NO_x, DPM, PM_{10} and GHG) from heavy-duty construction equipment and may include emulsified fuels, catalyst and filtration technologies, engine replacement, new alternative fueled trucks, and implementation of Construction Activity Management Plans (CAMP). The mitigation measures for construction activity fall into three separate sections:

- Standard Mitigation Measures
- Best Available Control Technologies (BACT) and Construction Activity Management Plans
  - Construction Activity Management Plans (CAMP)
  - Retrofit Devices and Alternative Fuels
  - Repowers
- Fugitive Dust Mitigation Measures

<u>Measure Applicability</u>
Measures should be applied as necessary to reduce construction impacts below the significance thresholds listed in Table 2-1. Construction equipment mitigation measures and construction activity management practices have been shown to significantly reduce emissions while maintaining overall equipment performance and project scheduling needs. Project proponents shall determine daily and quarterly construction phase impacts and define mitigation that will be implemented if impacts are expected to exceed the SLO County APCD's construction phase thresholds of significance.

The following list of standard and specific mitigation measures shall be incorporated into project conditions depending on the level of impacts. Ozone precursors (ROG + NO_x) are to be combined and compared to the SLO County APCD's construction phase significance thresholds. Applying the BACT for construction equipment or implementing a Construction Activity Management Plan is required when the Quarterly Tier 2 construction significance thresholds of 6.3 tons per quarter ROG + NO_x or 0.32 tons per quarter diesel PM are exceeded.

2.3.1 Standard Mitigation Measures for Construction Equipment

The standard mitigation measures for reducing nitrogen oxides (NO_x), reactive organic gases (ROG), and diesel particulate matter (DPM) emissions from construction equipment are listed below:

- Maintain all construction equipment in proper tune according to manufacturer's specifications;
- Fuel all off-road and portable diesel powered equipment with ARB certified motor vehicle diesel fuel (non-taxed version suitable for use off-road);
- Use diesel construction equipment meeting ARB's Tier 2 certified engines or cleaner off-road heavy-duty diesel engines, and comply with the State off-Road Regulation;

- Use on-road heavy-duty trucks that meet the ARB's 2007 or cleaner certification standard for on-road heavy-duty diesel engines, and comply with the State On-Road Regulation;
- Construction or trucking companies with fleets that that do not have engines in their fleet that meet the engine standards identified in the above two measures (e.g. captive or NO_x exempt area fleets) may be eligible by proving alternative compliance;
- All on and off-road diesel equipment shall not idle for more than 5 minutes. Signs shall be posted in the designated queuing areas and or job sites to remind drivers and operators of the 5 minute idling limit;
- Diesel idling within 1,000 feet of sensitive receptors is not permitted;
- Staging and queuing areas shall not be located within 1,000 feet of sensitive receptors;
- Electrify equipment when feasible;
- Substitute gasoline-powered in place of diesel-powered equipment, where feasible; and,
- Use alternatively fueled construction equipment on-site where feasible, such as compressed natural gas (CNG), liquefied natural gas (LNG), propane or biodiesel.

2.3.2 Best Available Control Technology (BACT) for Construction Equipment

If the estimated ozone precursor emissions from the actual fleet for a given construction phase are expected to exceed the APCD threshold of significance after the standard mitigation measures are factored into the estimation, then BACT needs to be implemented to further reduce these impacts. The BACT measures can include:

- Further reducing emissions by expanding use of Tier 3 and Tier 4 off-road and 2010 on-road compliant engines;
- Repowering equipment with the cleanest engines available; and
- Installing California Verified Diesel Emission Control Strategies. These strategies are listed at: http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm

2.3.3 Construction Activity Management Plan (CAMP) and Off-Site Mitigation

If the estimated construction emissions from the actual fleet are expected to exceed either of the APCD Quarterly Tier 2 thresholds of significance after the standard and BACT measures are factored into the estimation, then an APCD approved CAMP (see Technical Appendix 4.5 for CAMP Guidelines) and off-site mitigation need to be implemented in order to reduce potential air quality impacts to a level of insignificance.

CAMP

The CAMP should be submitted to the APCD for review and approval prior to the start of construction and should include, but not be limited to, the following elements:

- A Dust Control Management Plan that encompasses all, but is not limited to, dust control measures that were listed above in the "dust control measures" section;
- Tabulation of on and off-road construction equipment (age, horse-power and miles and/or hours of operation);
- Schedule construction truck trips during non-peak hours to reduce peak hour emissions;
- Limit the length of the construction work-day period, if necessary; and,
- Phase construction activities, if appropriate.

Off-Site Mitigation

It is important for the developer, lead agency, and SLO County APCD to work closely together whenever off-site mitigation is triggered. Off-site emission reductions can result from either stationary or mobile sources, but should relate to the on-site impacts from the project in order to provide proper "nexus" for the air quality mitigation. For example, NO_x emissions from a large grading project could be reduced by re-powering heavy-duty diesel construction equipment, thereby reducing the amount of NO_x generated from that equipment. An off-site mitigation strategy should be developed and agreed upon by all parties at least three months prior to the issuance of grading permits.

The current off-site mitigation rate is $16,000 per ton[1] of ozone precursor emission (NO_x + ROG) over the APCD threshold calculated over the length of the expected exceedance. The applicant may use these funds to implement APCD approved emission reduction projects near the project site or may pay that funding level plus an administration fee (2012 rate is 15%) to the APCD to administer emission reduction projects in close proximity to the project. The applicant shall provide this funding at least two (2) months prior to the start of construction to help facilitate emission offsets that are as real-time as possible.

Examples off-site mitigation strategies include, but are not limited to, the following:

- Fund a program to buy and scrap older heavy-duty diesel vehicles or equipment;
- Replace/repower transit buses;
- Replace/repower heavy-duty diesel school vehicles (i.e. bus, passenger or maintenance vehicles);
- Retrofit or repower heavy-duty construction equipment, or on-road vehicles;
- Repower or contribute to funding clean diesel locomotive main or auxiliary engines;
- Purchase VDECs for local school buses, transit buses or construction fleets;
- Install or contribute to funding alternative fueling infrastructure (i.e. fueling stations for CNG, LPG, conductive and inductive electric vehicle charging, etc.);
- Fund expansion of existing transit services; and,
- Replace/repower marine diesel engines.

2.4 FUGITIVE DUST MITIGATION MEASURES

Fugitive dust is particulate matter that is less than ten micros in size (PM_{10}) and is not emitted from defined point sources such as industrial smokestacks. Sources include open fields, graded or excavated areas, roadways, storage piles, etc.

All fugitive dust sources shall be managed to ensure that dust emissions are adequately controlled to below the 20% opacity limit identified in the APCD Rule 401 *Visible Emission*s and to ensure that dust is not emitted offsite. Projects shall implement one of the following fugitive dust mitigation sets to both minimize fugitive dust emissions and associated complaints that could result in a violation of the APCD Rule 402 *Nuisance*. The correct fugitive dust mitigation set for a given project depends on the project scale or proximity to sensitive receptors. The project proponent may propose other measures of equal or better effectiveness as replacements by contacting the APCD Panning Division.

<u>Fugitive Dust Mitigation Measures: Short List</u>

Projects with grading areas that are less than 4-acres and that are <u>not</u> within 1,000 feet of any sensitive receptor shall implement the following mitigation measures to minimize nuisance impacts and to significantly reduce fugitive dust emissions:

a. Reduce the amount of the disturbed area where possible;

b. Use water trucks or sprinkler systems in sufficient quantities to prevent airborne dust from leaving the site. Increased watering frequency would be required whenever wind speeds exceed 15 mph. Reclaimed (non-potable) water should be used whenever possible;

c. All dirt stock-pile areas should be sprayed daily as needed;

d. All roadways, driveways, sidewalks, etc. to be paved should be completed as soon as possible, and building pads should be laid as soon as possible after grading unless seeding or soil binders are used;

e. All of these fugitive dust mitigation measures shall be shown on grading and building plans; and

1 The value used to calculate off-site mitigation is based on the ARB approved Carl Moyer Grant Program and is updated on a periodic basis. The Carl Moyer cost effectiveness value as of 2009 is $16,000 per ton.

f. The contractor or builder shall designate a person or persons to monitor the fugitive dust emissions and enhance the implementation of the measures as necessary to minimize dust complaints, reduce visible emissions below 20% opacity, and to prevent transport of dust offsite. Their duties shall include holidays and weekend periods when work may not be in progress.

Fugitive Dust Mitigation Measures: Expanded List

Projects with grading areas that are greater than 4-acres or are within 1,000 feet of any sensitive receptor shall implement the following mitigation measures to minimize nuisance impacts and to significantly reduce fugitive dust emissions:

a. Reduce the amount of the disturbed area where possible;

b. Use of water trucks or sprinkler systems in sufficient quantities to prevent airborne dust from leaving the site. Increased watering frequency would be required whenever wind speeds exceed 15 mph. Reclaimed (non-potable) water should be used whenever possible;

c. All dirt stock pile areas should be sprayed daily as needed;

d. Permanent dust control measures identified in the approved project revegetation and landscape plans should be implemented as soon as possible following completion of any soil disturbing activities;

e. Exposed ground areas that are planned to be reworked at dates greater than one month after initial grading should be sown with a fast germinating, non-invasive grass seed and watered until vegetation is established;

f. All disturbed soil areas not subject to revegetation should be stabilized using approved chemical soil binders, jute netting, or other methods approved in advance by the APCD;

g. All roadways, driveways, sidewalks, etc. to be paved should be completed as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used;

h. Vehicle speed for all construction vehicles shall not exceed 15 mph on any unpaved surface at the construction site;

i. All trucks hauling dirt, sand, soil, or other loose materials are to be covered or should maintain at least two feet of freeboard (minimum vertical distance between top of load and top of trailer) in accordance with CVC Section 23114;

j. Install wheel washers where vehicles enter and exit unpaved roads onto streets, or wash off trucks and equipment leaving the site;

k. Sweep streets at the end of each day if visible soil material is carried onto adjacent paved roads. Water sweepers with reclaimed water should be used where feasible;

l. All of these fugitive dust mitigation measures shall be shown on grading and building plans; and

m. The contractor or builder shall designate a person or persons to monitor the fugitive dust emissions and enhance the implementation of the measures as necessary to minimize dust complaints, reduce visible emissions below 20% opacity, and to prevent transport of dust offsite. Their duties shall include holidays and weekend periods when work may not be in progress. The name and telephone number of such persons shall be provided to the APCD Compliance Division prior to the start of any grading, earthwork or demolition.

2.5 MITIGATION MONITORING

The APCD may conduct site visits to ensure that the construction phase air quality mitigation measures identified in the project's CEQA documents/conditions of approval were fully implemented. The lead agency may also review project mitigation for consistency with project conditions. Beyond verifying mitigation implementation, this monitoring can result in compliance requirements if mitigation measures are not sufficiently being implemented.

3 ASSESSING AND MITIGATING OPERATIONAL IMPACTS

Air pollutant emissions from urban development can result from a variety of sources, including motor vehicles, wood burning appliances, natural gas and electric energy use, combustion-powered utility equipment, paints and solvents, equipment or operations used by various commercial and industrial facilities, heavy-duty equipment and vehicles and various other sources. The air quality impacts that result from operational activities of a development project should be fully evaluated and quantified as part of the CEQA review process. The methods for evaluating and mitigating operational impacts from residential, commercial and industrial sources are discussed below.

3.1 OPERATIONAL SIGNIFICANCE CRITERIA

The APCD has established five separate categories of evaluation for determining the significance of project impacts. Full disclosure of the potential air pollutant and/or toxic air emissions from a project is needed for these evaluations, as required by CEQA:

a. Consistency with the most recent Clean Air Plan for San Luis Obispo County;

b. Consistency with a plan for the reduction of greenhouse gas emissions that has been adopted by the jurisdiction in which the project is located and that, at a minimum, complies with State CEQA Guidelines Section 15183.5.

c. Comparison of predicted ambient criteria pollutant concentrations resulting from the project to state and federal health standards, when applicable;

d. Comparison of calculated project emissions to SLO County APCD emission thresholds; and,

e. The evaluation of special conditions which apply to certain projects.

3.2 CONSISTENCY WITH THE SLO COUNTY APCD'S CLEAN AIR PLAN AND SMART GROWTH PRINCIPLES

A consistency analysis with the Clean Air Plan is required for a Program Level environmental review, and may be necessary for a Project Level environmental review, depending on the project being considered. Program-Level environmental reviews include but are not limited to General Plan Updates and Amendments, Specific Plans, Regional Transportation Plans and Area Plans. Project-Level environmental reviews which may require consistency analysis with the Clean Air Plan and Smart/Strategic Growth Principles adopted by lead agencies include: subdivisions, large residential developments and large commercial/industrial developments. The project proponent should evaluate if the proposed project is consistent with the land use and transportation control measures and strategies outlined in the Clean Air Plan. If the project is consistent with these measures, the project is considered consistent with the Clean Air Plan.

3.3 CONSISTENCY WITH A PLAN FOR THE REDUCTION OF GREENHOUSE GAS EMISSIONS

The APCD encourages local governments to adopt a qualified GHG reduction plan that is consistent with AB 32 goals. If a project is consistent with an adopted qualified GHG reduction plan it can be presumed that the project will not have significant GHG emission impacts. This approach is consistent with the State CEQA Guidelines, Section 15183.5 (see text in box below).

§15183.5. Tiering and Streamlining the Analysis of Greenhouse Gas Emissions.

(a) Lead agencies may analyze and mitigate the significant effects of greenhouse gas emissions at a programmatic level, such as in a general plan, a long range development plan, or a separate plan to reduce greenhouse gas emissions. Later project-specific environmental documents may tier from and/or incorporate by reference that existing programmatic review. Project-specific environmental documents may rely on an EIR containing a programmatic analysis of greenhouse gas emissions as provided in section 15152 (tiering), 15167 (staged EIRs) 15168 (program EIRs), 15175-15179.5 (Master EIRs), 15182 (EIRs Prepared for Specific Plans), and 15183 (EIRs Prepared for General Plans, Community Plans, or Zoning).

(b) Plans for the Reduction of Greenhouse Gas Emissions. Public agencies may choose to analyze and mitigate significant greenhouse gas emissions in a plan for the reduction of greenhouse gas emissions or similar document. A plan to reduce greenhouse gas emissions may be used in a cumulative impacts analysis as set forth below. Pursuant to sections 15064(h)(3) and 15130(d), a lead agency may determine that a project's incremental contribution to a cumulative effect is not cumulatively considerable if the project complies with the requirements in a previously adopted plan or mitigation program under specified circumstances.

(1) Plan Elements. A plan for the reduction of greenhouse gas emissions should:

(A) Quantify greenhouse gas emissions, both existing and projected over a specified time period, resulting from activities within a defined geographic area;

(B) Establish a level, based on substantial evidence, below which the contribution to greenhouse gas emissions from activities covered by the plan would not be cumulatively considerable;

(C) Identify and analyze the greenhouse gas emissions resulting from specific actions or categories of actions anticipated within the geographic area;

(D) Specify measures or a group of measures, including performance standards, that substantial evidence demonstrates, if implemented on a project-by-project basis, would collectively achieve the specified emissions level;

(E) Establish a mechanism to monitor the plan's progress toward achieving the level and to require amendment if the plan is not achieving specified levels;

(F) Be adopted in a public process following environmental review

(2) Use with Later Activities. A plan for the reduction of greenhouse gas emissions, once adopted following certification of an EIR or adoption of an environmental document, may be used in the cumulative impacts analysis of later projects. An environmental document that relies on a greenhouse gas reduction plan for a cumulative impacts analysis must identify those requirements specified in the plan that apply to the project, and, if those requirements are not otherwise binding and enforceable, incorporate those requirements as mitigation measures applicable to the project. If there is substantial evidence that the effects of a particular project may be cumulatively considerable notwithstanding the project's compliance with the specified requirements in the plan for the reduction of greenhouse gas emissions, an EIR must be prepared for the project.

Detailed information on preparing qualified GHG reduction plans is provided in the Technical Appendices 4.6 GHG Plan Level Guidance.

3.4 COMPARISON TO STANDARDS

State and federal ambient air quality standards are established to protect public health and welfare from the adverse impacts of air pollution; these standards are listed in Table 3-1. Industrial and large commercial projects are sometimes required to perform air quality dispersion modeling if the SLO County APCD determines that project emissions may have the potential to cause an exceedance of these standards. In such cases, models are used to calculate the potential ground-level pollutant concentrations resulting from the project. The predicted pollutant levels are then compared to the applicable state and federal standards. A project is considered to have a significant impact if its emissions are predicted to cause or contribute to a violation of any ambient air quality standard. In situations where the predicted standard violation resulted from the application of a "screening-level" model or calculation, it may be appropriate to perform a more refined modeling analysis to accurately estimate project impacts. If a refined analysis is not available or appropriate, then the impact must be mitigated to a level of insignificance or a finding of overriding considerations must be made by the permitting agency.

Table 3-1: Ambient Air Quality Standards (State and Federal)

Pollutant		Averaging Time	California Standard (1)	Federal Standard (2)
Ozone		1 Hour	0.09 ppm	
		8 Hour	0.070 ppm	0.075 ppm
Carbon Monoxide		8 Hour	9.0 ppm	9 ppm
		1 Hour	20 ppm	35 ppm
Nitrogen Dioxide		Annual Arithmetic Mean	0.030 ppm	0.053 ppm
		1 Hour	0.18 ppm	
Sulfur Dioxide		Annual Arithmetic Mean		0.030 ppm
		24 Hour	0.04 ppm	0.14 ppm
		3 Hour		0.5 ppm (secondary)
		1 Hour	0.25 ppm	
Respirable Particulate Matter	PM_{10}	Annual Arithmetic Mean	20 µg/m^3	
		24 Hour	50 µg/m^3	150 µg/m^3
Fine Particulate Matter	$PM_{2.5}$	Annual Arithmetic Mean	12 µg/m^3	15.0 µg/m^3
		24 Hour		35 µg/m^3
Hydrogen Sulfide		1 Hour	0.03 ppm	
Vinyl Chloride		24 Hour	0.01 ppm	
Sulfates		24 Hour	25 µg/m^3	
Lead			30 day average: 25 µg/m^3	Rolling 3-month average:0.15 µg/m^3 Calendar quarter: 1.5 µg/m^3
Visibility Reducing Particles		8 Hour	Extinction coefficient of 0.23 per kilometer – visibility of ten miles or more due to particles when relative humidity is less than 70 percent. Method: Beta Attenuation and Transmittance through Filter Tape.	

1. California standards for ozone, carbon monoxide (except Lake Tahoe), nitrogen dioxide, sulfur dioxide (1-hour and 24-hour), $PM_{2.5}$, PM_{10} and visibility reducing particles are values that are not to be exceeded. All other state standards are not to be equaled or exceeded.

2. Federal standards are not to be exceeded more than once in any calendar year. The ozone standard is attained when the fourth highest eight hour concentration in a year, averaged over three years, is equal to or less than the standard. For PM_{10}, the 24 hour standard is attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m^3 is equal to or less than one. For $PM_{2.5}$, the 24 hour standard is attained when the 98 percent of the daily concentration, average over three years, are equal to or less than the standard.

3.5 COMPARISON TO SLO COUNTY APCD OPERATIONAL EMISSION THRESHOLDS

Emissions which exceed the designated threshold levels are considered potentially significant and should be mitigated.

A Program Level environmental review, such as for a General Plan, Specific Plan or Area Plan however, does not require a quantitative air emissions analysis at the project scale. A qualitative analysis of the air quality impacts should be conducted instead, and should be generated for each of the proposed alternatives to be considered. The qualitative analysis of each alternative should be based upon criteria such as prevention of urban sprawl and reduced dependence on automobiles. A finding of significant impacts can be determined qualitatively by comparing consistency of the project with the Transportation and Land Use Planning Strategies outlined in the APCD's Clean Air Plan. Refer to Section 3.2 for more information.

Section 3.7 of this document provides guidance on the type of mitigation recommended for varying levels of impact and presents a sample list of appropriate mitigation measures for different types of projects.

3.5.1 Significance Thresholds for Project-Level Operational Emissions

The threshold criteria established by the SLO County APCD to determine the significance and appropriate mitigation level for **long-term operational** emissions from a project are presented in Table 3-2.

Table 3-2: Thresholds of Significance for Operational Emissions Impacts

Pollutant	Threshold(1)	
	Daily	Annual
Ozone Precursors (ROG + NO_x)(2)	25 lbs/day	25 tons/year
Diesel Particulate Matter (DPM)(2)	1.25 lbs/day	
Fugitive Particulate Matter (PM_{10}), Dust	25 lbs/day	25 tons/year
CO	550 lbs/day	
Greenhouse Gases (CO_2, CH_4, N20, HFC, CFC, F6S)	Consistency with a Qualified Greenhouse Gas Reduction Plan OR 1,150 MT CO_2e/year OR 4.9 CO_2e/SP/year (residents + employees)	

1. Daily and annual emission thresholds are based on the California Health & Safety Code Division 26, Part 3, Chapter 10, Section 40918 and the CARB Carl Moyer Guidelines for DPM.
2. CalEEmod – use winter operational emission data to compare to operational thresholds.

Most of the **long-term operational mitigation strategies** suggested in Section 3.7 focus on methods to reduce vehicle trips and travel distance, including site design standards which encourage pedestrian and bicycle-friendly, transit-oriented development. In addition, the recommendations include design strategies for residential and commercial buildings that address energy conservation and other concepts to reduce total project emissions. These recommendations are not all inclusive and are provided as examples among many possibilities.

3.5.2 Ozone Precursor (ROG + NO_x) Emissions

- If the project's ozone precursor emissions are below the APCD's **25 lbs/day** (combined ROG + NO_x emissions) no ozone mitigation measures are necessary. The Lead Agency will prepare the appropriate, required environmental document(s).

- Projects which emit **25 lb/day** or more of ozone precursors (ROG + NO_x combined) have the potential to cause significant air quality impacts, and should be submitted to the SLO County APCD for review. On-site mitigation measures, following the guidelines in Section 3.7 (*Operational Emission Mitigation*), are recommended to reduce air quality impacts to a level of insignificance.

  If all feasible mitigation measures are incorporated into the project and emissions can be reduced to less than 25 lbs/day, then the Lead Agency will prepare the appropriate, required environmental document(s).

  If all feasible mitigation measures are incorporated into the project and emissions are still greater than 25 lbs/day, then an ENVIRONMENTAL IMPACT REPORT should be prepared. Additional mitigation measures, including off-site mitigation, may be required depending on the level and scope of air quality impacts identified in the EIR.

- Projects which emit **25 tons/year** or more of ozone precursor (ROG + NO_x combined), require the preparation of an ENVIRONMENTAL IMPACT REPORT. Depending upon the level and scope of air quality impacts identified in the EIR, mitigation measures, including off-site mitigation, may be required to reduce the overall air quality impacts of the project to a level of insignificance.

3.5.3 Diesel Particulate Matter (DPM) Emissions

Diesel particulate matter (DPM) is seldom emitted from individual projects in quantities which lead to local or regional air quality attainment violations. DPM is, however, a toxic air contaminant and carcinogen, and exposure DPM may lead to increased cancer risk and respiratory problems. Certain industrial and commercial projects may emit substantial quantities of DPM through the use of stationary and mobile on-site diesel-powered equipment as well diesel trucks and other vehicles that serve the project.

Projects that emit more than **1.25 lbs/day** of DPM need to implement on-site Best Available Control Technology measures. If sensitive receptors are within 1,000 feet of the project site, a Health Risk Assessment (HRA) may also be required. Sections 3.5.1 and 3.6.4 of this Handbook provide more background on HRAs in conjunction with CEQA review. Guidance on the preparation of a HRA may be found in the CAPCOA report *HEALTH RISK ASSESSMENT FOR PROPOSED LAND USE PROJECTS* which can be downloaded from the CAPCOA website at www.capcoa.org.

3.5.4 Fugitive Particulate Matter (Dust) Emissions

Projects which emit more than **25 lbs/day** or **25 tons/year** of fugitive particulate matter need to implement permanent dust control measures to mitigate the emissions below these thresholds or provide suitable off-site mitigation approved by the APCD. Operational fugitive dust emissions from a proposed project are calculated using the CALEEMOD model discussed in Section 3.6.1. Typical sources of operational emissions included the following:

- Paved roadways: Vehicular traffic on paved roads that are used to accesses large residential, commercial, or industrial projects can generate significant dust emissions.

- Off and/or on-site unpaved roads or surfaces: Even at low traffic volume, vehicular traffic on unpaved roads or surfaces that are used to accesses residential, commercial, or industrial operations or that accesses special events, etc. can generate significant dust emissions
- Industrial and/or commercial operations: Certain industrial operations can generate significant dust emissions associated with vehicular access, commercial or industrial activities.

Any of the above referenced land uses or activities can result in dust emissions that exceed the APCD significance thresholds, cause violations of an air quality standard, or create a nuisance impact in violation of APCD Rule 402 *Nuisance*. In all cases where such impacts are predicted, appropriate fugitive dust mitigation measures shall be implemented.

3.5.5 Carbon Monoxide (CO) Emissions

Carbon monoxide is a colorless, odorless, tasteless gas emitted during combustion of carbon-based fuels. While few land use projects result in high emissions of CO, this pollutant is of particular concern when emitted into partially or completely enclosed spaces such as parking structures and garages. Projects which emit more than 550 lbs/day of carbon monoxide (CO) and occur in a confined or semi-confined space (e.g., parking garage or enclosed indoor stadium) must be modeled to determine their significance. In confined or semi-confined spaces where vehicle activity occurs, CO modeling is required. If modeling shows the potential to violate the State CO air quality standard, mitigation or project redesign is required to reduce CO concentrations to a level below the health-based standard.

3.5.6 Greenhouse Gas Emissions

GHGs (CO_2, $CH_{4,}$ N20, HFC, CFC, F6S) from all projects subject to CEQA must be quantified and mitigated to the extent feasible. The thresholds of significance for a project's amortized construction plus operational-related GHG emissions are:

- For land use development projects, the threshold is compliance with a qualified GHG Reduction Strategy (see Section 3.3); OR annual emissions less than 1,150 metric tons per year (MT/yr) of CO_2e; ORr 4.9 MT CO_2e/service population (SP)/yr (residents + employees2). Land use development projects include residential, commercial and public land uses and facilities. Lead agencies may use any of the three options above to determine the significance of a project's GHG emission impact to a level of certainty.

- For stationary-source projects, the threshold is 10,000 metric tons per year (MT/yr) of CO_2e. Stationary-source projects include land uses that would accommodate processes and equipment that emit GHG emissions and would require an APCD permit to operate.

The APCD's GHG threshold is defined in terms of carbon dioxide equivalent (CO_2e), a metric that accounts for the emissions from various greenhouse gases based on their global warming potential. If annual emissions of GHGs exceed these threshold levels, the proposed project would result in a cumulatively considerable contribution of GHG emissions and a cumulatively significant impact to global climate change. More detailed information on the greenhouse gas thresholds can be found in the APCD's *Greenhouse Gas Thresholds and Supporting Evidence* document (March 28, 2012) that is available at www.slocleanair.org.

3.6 SPECIAL CONDITIONS

Projects may require additional assessments as described in the following section.

2 For projects where the employment is unknown, please refer to Appendix 4.7 "Employees per 1000sf" to estimate the number of employees associated with any project.

3.6.1 Toxic Air Contaminants

Health Risk Assessments

If a project has the potential to emit toxic or hazardous air pollutants, or is located in close proximity to sensitive receptors, impacts may be considered significant due to increased cancer risk for the affected population, even at a very low level of emissions. Such projects may be required to prepare a risk assessment to determine the potential level of risk associated with their operations. The SLO County APCD should be consulted on any project with the potential to emit toxic or hazardous air pollutants. Pursuant to the requirements of California Health and Safety Code Section 42301.6 (AB 3205) and Public Resources Code Section 21151.8, subd. (a)(2), any new school, or proposed industrial or commercial project site located within 1000 feet of a school must be referred to the SLO County APCD for review. Further details on requirements for projects in this category are presented in Section 4.1.

In April of 2005, the California ARB issued the *AIR QUALITY AND LAND USE HANDBOOK: A COMMUNITY HEALTH PERSPECTIVE* (Land Use Handbook). The ARB has determined that emissions from sources such as roadways and distribution centers and, to a lesser extent gas stations, certain dry cleaners, marine ports and airports as well as refineries can lead to unacceptably high health risk from diesel particulate matter and other toxic air contaminants (TACs). Groups such as children and the elderly, as well as long-term residential occupants, are particularly at risk from toxic exposure.

In July 2009, the California Air Pollution Control officers Associations (CAPCOA) adopted a guidance document *HEALTH RISK ASSESSMENTS FOR PROPOSED LAND USE PROJECTS* to provide uniform direction on how to assess the health risk impacts from and to proposed land use projects. The CAPCOA guidance document focuses on how to identify and quantify the potential acute, chronic, and cancer impacts of sources under CEQA review. It also outlines the recommended procedures to identify when a project should undergo further risk evaluation, how to conduct the health risk assessment (HRA), how to engage the public, what to do with the results from the HRA, and what mitigation measures may be appropriate for various land use projects.

As defined in the CAPCOA guidance document there are basically two types of land use projects that have the potential to cause long-term public health risk impacts:

- Type A Projects: new proposed land use projects that generate toxic air contaminants (such as gasoline stations, distribution facilities or asphalt batch plants) that impact sensitive receptors. Air districts across California are uniform in their recommendation to use the significance thresholds that have been established under each district's "Hot Spots" and permitting programs. The APCD has defined the excess cancer risk significance threshold at **10 in a million** for Type A projects in SLO County; and,

- Type B Projects: new land use projects that will place sensitive receptors (e.g., residential units) in close proximity to existing toxics sources (e.g., freeway). The APCD has established a CEQA health risk threshold of **89 in-a-million** for the analysis of projects proposed in close proximity to toxic sources. This value represents the population weighted average health risk caused by ambient background concentrations of toxic air contaminants in San Luis Obispo County. The APCD recommends Health Risk screening and, if necessary, Health Risk Assessment (HRA) for any residential or sensitive receptor development proposed in proximity to toxic sources.

If a project is located near a sensitive receptor (e.g., school, hospital, dwelling unit(s), etc.), it may be considered significant even if other criteria do not apply. The health effects of a project's emissions may be more pronounced if they impact a considerable number of children, elderly, or people with compromised respiratory or cardiac conditions.

Diesel PM

In October of 2000, the ARB issued and adopted the Diesel Risk Reduction Plan to reduce particulate matter emissions from diesel-fueled engines and vehicles. This plan identified that 70% of the airborne toxic risk in California is from diesel particulate matter.

The plan called for a 90% reduction in this Toxic Air Contaminant by 2020 through:

a. Adoption of new regulatory standards for all new on-road, off-road, and stationary diesel-fueled engines and vehicles;

b. Requiring feasible and cost-effective diesel PM reducing retrofit requirements for the existing fleets and stationary engines; and,

c. Reducing the sulfur content in diesel-fuel sold in California to 15 parts per million.

At a minimum, fleets must meet the diesel emission reduction requirements that have been adopted in the State's Diesel Risk Reduction Plan. These fleets may also be required to provide additional mitigation depending on the project's emissions and location.

Asbestos / Naturally Occurring Asbestos

Naturally occurring asbestos (NOA) has been identified by the state Air Resources Board as a toxic air contaminant. Serpentine and ultramafic rocks are very common throughout California and may contain naturally occurring asbestos. The SLO County APCD has identified areas throughout the County where NOA may be present (see Technical Appendix 4.4). Under the ARB's Air Toxic Control Measure (ATCM) related to quarrying, and surface mining operations, a geologic evaluation is required to determine if NOA is present prior to any grading activities at a project site located in the candidate area.

If NOA is found at the site the applicant must comply with all requirements outlined in the Asbestos ATCM for Quarrying, and Surface Mining Operations. These requirements may include but are not limited to:

a. Development of an Asbestos Dust Mitigation Plan which must be approved by the APCD before operations begin, and,

b. Development and approval of an Asbestos Health and Safety Program (required for some projects).

If NOA is not present, an exemption request must be filed with the Air District. More information on NOA can be found at http://www.slocleanair.org/business/asbestos.asp.

3.6.2 Agricultural Operations

Wineries, Tasting Rooms and Special Events

Reactive organic gas emissions (ethanol) generated during wine fermentation and storage, as well as emissions from equipment used in wine production, can cause significant air quality impacts. Thus, the emissions for new or modified winery operations and activities should be evaluated and appropriate mitigation specified when necessary. New or expanding wineries with storage capacity of 26,000 gallons per year or more may also require a Permit to Operate from the APCD.

Wine production facilities can also generate nuisance odors during various steps of the process. Proven methods for handling wastewater discharge and grape skin waste need to be incorporated into the winery practices to minimize the occurrence of anaerobic processes that mix with ambient air which can result in offsite nuisance odor transport. Odor complaints could result in a violation of the SLO County APCD Rule 402 *Nuisance*.

Agricultural Burns

Agricultural operations must obtain an APCD Agricultural Burn Permit to burn dry agricultural vegetation on Permissive Burn Days. The ARB provides educational handbooks on agricultural burning (English and Spanish) to growers which are available at the following websites:

-www.arb.ca.gov/cap/handbooks/agburningsmall.pdf

-www.arb.ca.gov/cap/handbooks/agburningspanishsmall.pdf.

3.6.3 Fugitive Dust

Fugitive dust can come from many sources, such as unpaved roads, equestrian facilities and confined animal feeding operations. Dust emissions from the operational phase of a project should be managed to ensure they do not impact offsite areas and do not exceed the 20% opacity limit identified in SLO County APCD Rule 401 *Visible Emissions*. A list of approved dust control suppressants is available in Technical Appendix 4.3. The approved suppressants must be reapplied at a frequency that ensures dust emissions will not exceed the limits stated above. Any chemical or organic material used for stabilizing solids shall not violate the California State Water Quality Control Board standards for use as a soil stabilizer. Any dust suppressant must not be prohibited for use by the US Environmental Protection Agency, the California Air Resources Board, or other applicable law, rule, or regulation.

Equestrian Facilities

Another potential source of fugitive dust can come from equestrian facilities, which may be a nuisance to local residents. To minimize nuisance impacts and to reduce fugitive dust emissions from equestrian facilities the following mitigation measures should be incorporated into the project:

- Reduce the amount of the disturbed area where possible;
- Use water trucks or sprinkler systems in sufficient quantities to prevent airborne dust from leaving the site. Increased watering frequency whenever wind speeds exceed 15 mph. Reclaimed (non-potable) water shall be used whenever possible;
- Permanent dust control measures shall be implemented as soon as possible following completion of any soil disturbing activities;
- All disturbed soil areas not subject to revegetation shall be stabilized using approved chemical soil binders, jute netting, or other methods approved in advance by the Air District;
- All access roads and parking areas associated with the facility shall be paved to reduce fugitive dust; and,
- A person or persons shall be designated to monitor for dust and implement additional control measures as necessary to prevent transport of dust offsite. The monitor's duties shall include holidays and weekend. The name and telephone number of such persons shall be provided to the Air District prior to operation of the arena.

Dirt Roads and Unpaved Areas

When a project is accessed by unpaved roads and or has unpaved driveways or parking areas, a PM_{10} emission estimate needs to be conducted using the CALEEMOD model. When the model's emission estimate demonstrates an exceedance of the 25 lbs of PM_{10}/day or 25 tons of PM_{10}/year APCD thresholds, the following mitigation is required:

For the unpaved road leading to the project location, implement one of the following:

a. For the life of the project, pave and maintain the driveway; or,

b. For the life of the project, maintain the private unpaved driveway with a dust suppressant (See Technical Appendix 4.3 for a list of APCD-approved suppressants) such that fugitive dust emissions do not impact off-site areas and do not exceed the APCD 20% opacity limit.

To improve the dust suppressant's long-term efficacy, the applicant shall also implement and maintain design standards to ensure vehicles that use the on-site unpaved road are physically limited (e.g., speed bumps) to a posted speed limit of 15 mph or less.

If the project involves a city or county owned and maintained road, the applicant shall work with the Public Works Department to ensure road standards are followed. The applicant may propose other measures of equal effectiveness as replacements by contacting the APCD Planning Division.

Special Event Mitigation
When a special event is accessed by unpaved roads and or has unpaved driveways or parking areas, a PM_{10} emission estimate must to be conducted using the CALEEMOD model. If the model shows an exceedance of the 25 lbs/day of PM_{10} significance threshold, the following mitigation is required on the day(s) of the special event:

a. Designated parking locations shall be:
    1. Paved when possible;
    2. Sited in grass or low cut dense vegetative areas; or,
    3. Treated with a dust suppressant such that fugitive dust emissions do not impact offsite areas and do not exceed the APCD 20% opacity limit (see Technical Appendix 4.3).

b. Any unpaved roads/driveways that will be used for the special event shall be maintained with an APCD-approved dust suppressant such that fugitive dust emissions do not impact offsite areas and do not exceed the APCD 20% opacity limit.

The applicant may propose alternative measures of equal effectiveness by contacting the APCD Planning Division.

3.6.4 Air Quality Nuisance Impacts

If a project has the potential to cause an odor or other nuisance problem which could impact a considerable number of people, then it may be considered significant. A project may emit a pollutant in concentrations that would not otherwise be significant except as a nuisance. Odor impacts on residential areas and other sensitive receptors warrant the closest scrutiny, but consideration should also be given to other land uses where people may congregate, such as recreational facilities, work sites and commercial areas.

When making a determination of odor significance, determine whether the project would result in an odor source located next to potential receptors within the distances indicated in Table 3-3. The Lead Agency should evaluate facilities not included in Table 3-3 or projects separated by greater distances than indicated in Table 3-3 if warranted by local conditions or special circumstances. The list is provided as a guide and, as such, is not all-inclusive.

If a project is proposed within the screening level distances in Table 3-3, the APCD Enforcement Division should be contacted for information regarding potential odor problems. For projects that involve new receptors located near an existing odor source(s), an information request should be submitted to the SLO County APCD to review the inventory of odor complaints for the nearest odor emitting facility(ies) during the previous three years. For projects involving new receptors to be located near an existing odor source where there is currently no nearby development, and for new odor sources locating near existing receptors, the information request and analysis should be based on a review of odor complaints for similar facilities.

Table 3-3: Project Screening Distances for Nuisance Sources

PROJECT SCREENING DISTANCES	
Type of Operation	**Project Screening Distance**
Asphalt Batch Plant	1 mile
Chemical Manufacturing	1 mile
Coffee Roaster	1 mile
Composting Facility	1 mile
Fiberglass Manufacturing	1 mile
Food Processing Facility	1 mile
Oil Field	1 mile
Painting/Coating Operations (e.g. auto body shops)	1 mile
Petroleum Refinery	2 miles
Rendering Plant	1 mile
Sanitary Landfill	1 mile
Transfer Station	1 mile
Wastewater Treatment Plant	1 mile

Note: This list is provided as a guide and is not all-inclusive.

For a project that will be located near an existing odor source the project should be identified as having a significant odor impact, if it will be as close or closer to the any location that has experienced: 1) more than one confirmed complaint per year averaged over a three year period, or 2) three unconfirmed complaints per year averaged over a three year period.

If a proposed project is determined to result in potential odor problems, mitigation measures should be identified. For some projects, add-on controls or process changes, such as carbon absorption, incineration or an engineering modification to stacks/vents, can reduce odorous emissions. In many cases, however, the most effective mitigation strategy is the provision of a sufficient distance, or buffer zone, between the source and the receptor(s).

The SLO County APCD should be consulted whenever any of these additional special conditions may be applicable for a proposed project.

3.7 METHODS FOR CALCULATING PROJECT OPERATIONAL EMISSIONS

Operational phase air pollutant emissions from urban development can result from a variety of sources, including motor vehicles, wood burning appliances, natural gas and electric energy use, combustion-powered utility equipment, paints and solvents, equipment or operations used by various commercial and industrial facilities, construction and demolition equipment and operations, and various other sources. The amount and type of emissions produced, and their potential to cause significant impacts, depends on the type and level of development proposed. The following sections describe the recommended methods generally used to calculate emissions from motor vehicles, congested intersections and roadways, non-vehicular sources at residential and commercial facilities, and industrial point and area sources. Calculation and mitigation of construction emissions are described separately in Chapter 2.

Submittals describing project assessments must include spreadsheets with project calculations and a description of calculations so that the APCD can verify project quantification. **Calculations must be based on San Luis Obispo County default conditions unless the default settings are not representative of the project** (see below). The project report must detail assumptions made and provide sample calculations. Prior to finalizing the calculations, contact the APCD Planning and Outreach Division to review assumptions that do not have solid evidential support.

3.7.1 Determining Motor Vehicle Emissions

Motor vehicles are a primary source of long-term emissions from many residential, commercial, institutional, and industrial land uses. These land uses often do not emit significant amounts of air pollutants directly, but cause or attract motor vehicle trips that do produce emissions. Such land uses are referred to as indirect sources.

Motor vehicle emissions associated with indirect sources should be calculated for projects which exceed or are within 10 % of the screening criteria listed in Table 1-1. Calculations should be performed using the latest version of CALEEMOD; this software incorporates the most recent vehicle emission factors from the EMFAC model (i.e., EMission FACtors) provided by the California Air Resources Board (ARB), and average trip generation factors published by the Institute of Transportation Engineers (ITE). The latest version of this program should always be used and can be downloaded free of charge at www.caleemod.com.

CalEEMod is a planning tool for estimating vehicle miles travel, fuel use and resulting emissions related to land use projects throughout California. The model calculates emissions of ROG, NO_x, CO, and CO_2 and other GHGs as well as dust and exhaust PM_{10} from vehicle use associated with new or modified development such as shopping centers, housing, commercial services, industrial land uses, etc. CALEEMOD includes many default values for parameters such as

- Seasonal Average Temperature;
- Humidity;
- Wood and gas stoves in a residential development and their usage;
- Fleet mix;
- Average vehicle speed and age;
- Average urban, rural, commute, shopping, and other trip type distances; and,
- Average trip rates for each land use.

When modeling project emissions, the user must specify that the project is located in SLO County so that the appropriate default values are used for the modeling. Motor vehicle-related defaults should not be changed without justification for doing so; solid documentation of rationale for any changes made need to be provided to APCD as part of the air quality report. Defaults that need to be evaluated and modified based on the project location and specifications include:

- **Trip Length:** For projects that are located in rural areas of the county where commercial services are not readily available, the trip length default values in the Operational – Mobile Vehicle Trips CalEEMod tab need be set at 13 miles for all trip distances; this happens automatically if the "Rural" Land Use Setting.

- **Fleet Mix:** Projects that attract a mix of vehicles which clearly differs from the default vehicle fleet in SLO County should make the appropriate changes to the FleetMix fraction section on the Annual, Summer, and Winter subtabs under the CalEEMod Operational – Mobile Vehicle Emissions Tab. Some examples include large commercial retail with heavy on-road truck use and heavy industry.

- **Dirt and Roads:** Projects which include on- and off-site dirt access roads should modify the default Road Dust component to accurately assess the project's PM_{10} emissions. For general traffic, SLO County APCD recommends using the ARB's unpaved road emission factor of 2 pounds of particulate matter emissions per one mile of unpaved vehicle mile traveled (www.arb.ca.gov/ei/areasrc/fullpdf/FULL7-10.pdf). This value is not appropriate for heavy duty diesel truck travel on unpaved roads.

  The following are the APCD recommended values to use in CalEEMod's Operational – Mobile Road Dust tab to yield PM10 emissions using variable values that emulate the ARB's above identified unpaved road emission factor:

  - Under the "Paved Road Dust" section:

        - Change the "% Pave" value to define your project's paved road component by entering the results of the following calculation:
            - In general, the total distance of paved road driving (miles) is determined with:
                - [1 – (A/B)] x 100%
                - Where A = The unpaved road distance to access the project
                - Where B is typically = to the county average one way trip distance of 13 miles)
    - Under the "Unpaved Road Dust" section:
        - Use a value of 9.3 for "Material Silt Content (%)"
        - Use a value of 0.1 for "Material Moisture Content (%)"
        - Use a value of 32.4 for "Mean Vehicle Speed (mph)"

If the project has a total distance of unpaved road greater than 13 miles, the actual distance of the unpaved road should be compared to the total one-way trip length to determine the percentages of paved and unpaved road distances. In addition, the Trip Length in the Operational – Mobile Vehicle Trips tab needs to be updated by entering the total length of a one way trip for the project.

CalEEMod reports submitted as part of a CEQA evaluation need to include the following:

a. A winter, summer, and annual report;

b. The model files associated with the reports;

c. The SLO County APCD CEQA operational criteria pollutant thresholds should be compared to the Overall Operational winter total emissions (Note: ROG and NOx emission values are combined and compared to the 25 lb/day threshold);

d. The SLO County APCD CEQA operational GHG numerical threshold should be compared to the Overall Operational annual total CO2e emissions;

e. When summarizing modeling results in a CEQA document summary table always list the pollutants in the order they are listed in the model for ease of review; and,

f. Changes to any SLO County defaults need to be identified and a solid defensible explanation for those changes need to be provided to the APCD.

3.7.2 Non-Vehicular Emissions from Residential and Commercial Facilities

Non-vehicular emission sources associated with most residential and commercial development include energy use to power lights, appliances, heating and cooling equipment, evaporative emissions from paints and solvents, fuel combustion by lawnmowers, leaf blowers and other small utility equipment, residential wood burning, household products, and other small sources. Collectively, these are referred to as "area sources" and are important from a cumulative standpoint even though they may appear insignificant when viewed individually. The CALEEMOD model provides emissions estimations from area sources based on land use types; however it underestimates all emissions associated with electricity use and water consumption.

One CALEEMOD default area source value which has a significant impact on project emissions and may need to be changed is hearth fuel combustion – it is enabled by default and should be disabled or modified if the project excludes wood-burning devices.

3.7.3 Industrial Emission Sources

From an emissions standpoint, industrial facilities and operations are typically categorized as being "point" or "area" sources. Point sources are stationary and generally refer to a site that has one or more emission sources at a facility with an identified location (e.g., power plant, refinery, etc.). Area sources can be:

- Stationary or mobile and typically include categories of stationary facilities whose emissions are small individually, but may be significant as a group (e.g., gas stations, dry cleaners, etc.);
- Sources whose emissions emanate from a broad area (e.g., fugitive dust from storage piles and dirt roads, landfills, etc.); and,
- Mobile equipment used in industrial operations (e.g., drill rigs, loaders, haul-trucks, etc.).

Emissions from new, modified or relocated point sources are directly regulated through the APCD Rule 204 *New Source Review* requirements and facility permitting program. A general list of the type of sources affected by these requirements is provided in Section 4.1. New development that includes these source types should be forwarded to the SLO County APCD for a determination of APCD permitting and control requirements. Through the CEQA analysis, all air quality impacts are evaluated including the stationary point, area and mobile sources. While a specific piece of equipment or process may be covered by an APCD permit it is not excluded from the CEQA evaluation process.

3.7.4 Health Risk Assessment

Health risk is a common metric used by air quality and health scientists to describe the potential for an individual or group of people (population) in a given area to suffer serious health effects from long-term or short-term exposure to one or more toxic air contaminants (TACs). In July 2009, the California Air Pollution Control officers Association (CAPCOA) released a guidance document titled *HEALTH RISK ASSESSMENT FOR LAND USE PROJECTS*, which is available for download at www.capcoa.org. Attachment 1 of the CAPCOA document provides specific guidance on how to model emissions of toxic substances from various source types to determine the potential cancer risk as well as acute and chronic non-cancer health risks for nearby receptors.

A screening-level and/or refined health risk assessment (HRA) may be required for projects which may result in the exposure of sensitive receptors (e.g., school, hospital, dwelling unit(s), etc.) to TACs. Projects which involve the siting of **either** the TAC source itself **or** sensitive receptors in close proximity to a TAC should be evaluated for risk exposure. Various tools are available to perform a screening analysis from stationary sources impacting receptors (Type A projects).

For projects being impacted by existing sources (Type B projects), a distance table screening tool is available in the ARB Land Use Handbook which provides recommended buffer distances associated with types of most common toxic air contaminant sources (see Technical Appendix 4.2).

If a screening risk assessment shows that the potential risk exceeds the APCD's thresholds, then a more refined analysis may be required. The assessment should include the evaluation of both mobile and stationary sources. Risk assessments are normally prepared in a tiered manner, where progressively more input data is collected to refine the results. The refined analysis for the project should provide more accurate information for decision makers.

3.7.5 Greenhouse Gas Emissions

To quantify GHG emissions from a proposed development, the APCD recommends using CalEEMod for mobile sources and a partial characterization of area source impacts. In certain cases (e.g., drive-through restaurants), the use of alternative methodologies to quantify GHG impacts will be required. Please consult APCD Planning Division staff for current calculation methods.

3.8 OPERATIONAL EMISSION MITIGATION

Emissions from motor vehicles that travel to and from residential, commercial, and industrial land uses can generally be mitigated by reducing vehicle activity through site design (e.g., transit oriented design, infill, mixed use, etc.), implementing transportation demand management measures, using clean fuels and vehicles, and/or off-site mitigation. In addition, area source operational emissions from energy consumption from land uses can be mitigated by improving energy efficiencies, conservation measures and use of alternative energy sources. The mitigation measures in this section are intended to reduce emissions of ROG, NO_x, Diesel PM (DPM), Dust PM, and GHGs. The following three categories best capture the types of mitigation measures that can reduce air quality impacts from project operations:

- **Site Design Mitigation Measures:** Site design and project layout can be effective methods of mitigating air quality impacts of development. Land use development that incorporates urban infill, higher density, mixed use and walkable, bikeable, and transit oriented designs can significantly reduce vehicle activity and associated air quality impacts. As early as possible in the scoping phase of a project, the SLO County APCD recommends that developers and planners refer to the document *CREATING TRANSPORTATION CHOICES THROUGH DEVELOPMENT DESIGN AND ZONING* and Appendix E of the APCD Clean Air Plan *LAND USE AND CIRCULATION MANAGEMENT STRATEGIES.* APCD Planning Division staff is available to discuss project layout and design factors which can influence indirect source emissions and reduce mobile source emissions.

- **Energy Efficiency Mitigation Measures:** Residential and commercial energy use for lighting, heating and cooling is a significant source of direct and indirect air pollution nationwide. Reducing site and building energy demand will reduce emissions at the power plant source and natural gas combustion in homes and commercial buildings. The energy efficiency of both commercial and residential buildings can be improved by orienting buildings to maximize natural heating and cooling.

- **Transportation Mitigation Measures:** Vehicle emissions are often the largest continuing source of emissions from the operational phase of a development. Reducing the demand for single-occupancy vehicle trips is a simple, cost-effective means of reducing vehicle emissions. In addition, using cleaner fueled vehicles or retrofitting equipment with emission control devices can reduce the overall emissions without impacting operations. In today's marketplace, clean fuel and vehicle technologies exist for both passenger and heavy-duty applications.

3.8.1 Guidelines for Applying ROG, NO_x and PM_{10} Mitigation Measures

In general, projects which do not exceed the 25 lb/day ROG+NO_x threshold do not require mitigation. For projects which exceed this threshold, the SLO County APCD has developed a list of mitigation strategies for residential, commercial and industrial projects. Alternate mitigation measures may be suggested by the project proponent if the APCD-suggested measures are not feasible. Project mitigation recommendations should follow the guidelines listed below and summarized in Table 3-4:

a. Projects with the potential to generate 25 - 29 lbs/day of combined ROG + NO_x or PM_{10} emissions should select and implement at least **8** mitigation measures from the list;

b. Projects generating 30 - 34 lbs./day of combined ROG + NO_x or PM_{10} emissions should select and implement at least **14** mitigation measures list;

c. Projects generating 35 - 50 lbs./day of combined ROG + NO_x or PM_{10} emissions should implement at least **18** measures from the list;

d. Projects generating 50 lbs/day or more of combined ROG + NO_x or PM_{10} emissions should select and implement **all feasible** measures from the list. Further mitigation measures may also be necessary, including off-site measures, depending on the nature and size of the project and the effectiveness of the mitigation measures proposed; and,

e. Projects generating 25 tons per year or more of combined ROG + NO_x or PM_{10} emissions will need to implement **all feasible** measures from the list as well as **off-site** mitigation measures, depending on the nature and size of the project and the effectiveness of the onsite mitigation measures proposed.

Table 3-4: Mitigation Threshold Guide

Combined ROG+NO_x or PM_{10} Emissions (lbs/day)	Mitigation Measures Recommended	
	Residential, Commercial or Industrial	Off-Site Mitigation
< 25	None	None
25 – 29	8	*
30 – 34	14	*
35 – 50	18	*
≥ 50	All Feasible	*
≥ 25 ton/yr	All Feasible	Yes

* Will be dependent on the effectiveness of the mitigation measures, location of project and high vehicle dependent development. Examples of projects potentially subject to off-site mitigation include: rural subdivisions, drive-through applications, commercial development located far from urban core.

3.8.2 Standard Mitigation Measures

The recommended standard air quality mitigation measures have been separated according to land use (i.e., residential, commercial and industrial), measure type (i.e., site design, energy efficiency and transportation) and pollutant reduced (i.e., ozone, particulate, diesel PM, and GHGs). Any project generating 25 lbs/day or more of ROG + NO_x or PM_{10} should select the applicable number of mitigation measure as outlined above from Table 3-5 to reduce the air quality impacts from the project below the significance thresholds. This table also provides recommended mitigations for diesel PM and GHG emissions. For projects that exceed the DPM threshold (i.e., 1.25 lbs/day) due to significant diesel vehicle activity (e.g., mining operations, distribution facilities, etc.), project emissions must be recalculated to demonstrate that the project emissions are below the APCD DPM threshold of significance when mitigation measures are included.

Table 3-5: Mitigation Measures

LAND USE **Residential (R)** **Commercial (C)** **Industrial (I)**	**Measure Type**	**MITIGATION MEASURE**	**POLLUTANT REDUCED** **Ozone (O)** **Particulate (P)** **Diesel Particulate Matter (DPM)** **Greenhouse Gas (GHG)**
R, C, I	Site design, Transportation	Improve job / housing balance opportunities within communities.	O, P, GHG
R, C, I	Site design	Orient buildings toward streets with automobile parking in the rear to promote a pedestrian-friendly environment.	O, P, GHG
R, C, I	Site design	Provide a pedestrian-friendly and interconnected streetscape to make walking more convenient, comfortable and safe (including appropriate signalization and signage).	O, P, GHG
R, C, I	Site design	Provide good access to/from the development for pedestrians, bicyclists, and transit users.	O, P, GHG
R, C, I	Site design	Incorporate outdoor electrical outlets to encourage the use of electric appliances and tools.	O, P, GHG
R, C, I	Site design	Provide shade tree planting in parking lots to reduce evaporative emissions from parked vehicles. Design should provide 50% tree coverage within 10 years of construction using low ROG emitting, low maintenance native drought resistant trees.[3]	O P GHG
R, C, I	Site design	Pave and maintain the roads and parking areas	P
R, C, I	Site design	Driveway design standards (e.g., speed bumps, curved driveway) for self-enforcing of reduced speed limits for unpaved driveways.	P
R, C, I	Site design	Use of an APCD-approved suppressant on private unpaved roads leading to the site, unpaved driveways and parking areas; applied at a rate and frequency that ensures compliance with APCD Rule 401, visible emissions and ensures offsite nuisance impacts do not occur.	P
R, C	Site design	Development is within 1/4 mile of transit centers and transit corridors.	O, P, GHG
R, C	Site design	Design and build compact communities in the urban core to prevent sprawl.	O, P, GHG
R, C	Site design	Increase density within the urban core and urban reserve lines.	O, P, GHG
R, C	Site design	For projects adjacent to high-volume roadways or railroad idling zones, design project to include provide effective buffer zone between the source and the receptor.	DPM
R, C	Site design	For projects adjacent to high-volume roadways, plant vegetation[4] between receptor and roadway.	DPM, P
R	Site design	No residential wood burning appliances.	O, P, GHG
R, C, I	Site design, Transportation	Incorporate traffic calming modifications to project roads, such as narrower streets, speed platforms, bulb-outs and intersection designs that reduce vehicles speeds and encourage pedestrian and bicycle travel.	O, P, GHG
R, C, I	Site design, Transportation	Increase number of connected bicycle routes/lanes in the vicinity of the project.	O, P, GHG
R, C, I	Site design, Transportation	Provide easements or land dedications and construct bikeways and pedestrian walkways.	O, P, GHG
R, C, I	Site design, Transportation	Link cul-de-sacs and dead-end streets to encourage pedestrian and bicycle travel to adjacent land uses.	O, P, GHG
R, C, I	Site design, Transportation	Project is located within one-half mile of a ‘Park and Ride’ lot or project installs a ‘Park and Ride’ lot with bike lockers in a location of need defined by SLOCOG.	O, P, GHG
C, I	Site design, Transportation	Provide onsite housing for employees.	O, P, GHG

3 Trees must be maintained for life of project
4 Certain types of vegetation provide maximum effectiveness. Vegetation must be maintained over the life of the project.

LAND USE Residential (R) Commercial (C) Industrial (I)	Measure Type	MITIGATION MEASURE	**POLLUTANT REDUCED** Ozone (O) Particulate (P) Diesel Particulate Matter (DPM) Greenhouse Gas (GHG)
C, I	Site design, Transportation	Implement on-site circulation design elements in parking lots to reduce vehicle queuing and improve the pedestrian environment.	O, P, GHG
C, I	Site design, Transportation	Provide employee lockers and showers. One shower and 5 lockers for every 25 employees are recommended.	O, P, GHG
C, I	Site design, Transportation	Parking space reduction to promote bicycle, walking and transit use.	O, P, GHG
R	Site design	Tract maps resulting in parcels of one-half acre or les shall orient at least 75% of all lot lines to create easy due south orientation of future structures.	GHG
R	Site design	Trusses for south-facing portions of roofs shall be designed to handle dead weight loads of standard solar-heated water and photovoltaic panels. Roof design shall include sufficient south-facing roof surface, based on structures size and use, to accommodate adequate solar panels. For south facing roof pitches, the closest standard roof pitch to the ideal average solar exposure shall be used.	O, GHG
R, C, I	Energy efficiency	Increase the building energy rating by 20% above Title 24 requirements. Measures used to reach the 20% rating cannot be double counted.	O, GHG
R, C, I	Energy efficiency	Plant drought tolerant, native shade trees along southern exposures of buildings to reduce energy used to cool buildings in summer.[5]	O, GHG
R, C, I	Energy efficiency	Utilize green building materials (materials which are resource efficient, recycled, and sustainable) available locally if possible.	O, DPM, GHG
R, C, I	Energy efficiency	Install high efficiency heating and cooling systems.	O GHG
R, C, I	Energy efficiency	Orient 75 percent or more of homes and/or buildings to be aligned north / south to reduce energy used to cool buildings in summer.	O GHG
R, C, I	Energy efficiency	Design building to include roof overhangs that are sufficient to block the high summer sun, but not the lower winter sun, from penetrating south facing windows (passive solar design).	O, GHG
R, C, I	Energy efficiency	Utilize high efficiency gas or solar water heaters.	O, P, GHG
R, C, I	Energy efficiency	Utilize built-in energy efficient appliances (i.e. Energy Star®).	O, P GHG
R, C, I	Energy efficiency	Utilize double-paned windows.	O, P, GHG
R, C, I	Energy efficiency	Utilize low energy street lights (i.e. sodium).	O, P, GHG
R, C, I	Energy efficiency	Utilize energy efficient interior lighting.	O, P, GHG
R, C, I	Energy efficiency	Utilize low energy traffic signals (i.e. light emitting diode).	O, P, GHG
R, C, I	Energy efficiency	Install door sweeps and weather stripping (if more efficient doors and windows are not available).	O, P, GHG
R, C, I	Energy efficiency	Install energy-reducing programmable thermostats.	O, P, GHG
R, C, I	Energy efficiency	Participate in and implement available energy-efficient rebate programs including air conditioning, gas heating, refrigeration, and lighting programs.	O, P, GHG

5 Trees must be maintained for the life of the project

LAND USE Residential (R) Commercial (C) Industrial (I)	Measure Type	MITIGATION MEASURE	**POLLUTANT REDUCED** Ozone (O) Particulate (P) Diesel Particulate Matter (DPM) Greenhouse Gas (GHG)
R, C, I	Energy efficiency	Use roofing material with a solar reflectance values meeting the EPA/DOE Energy Star® rating to reduce summer cooling needs.	O, P, GHG
R, C, I	Energy efficiency	Utilize onsite renewable energy systems (e.g., solar, wind, geothermal, low-impact hydro, biomass and bio-gas).	O, P, GHG
R, C, I	Energy efficiency	Eliminate high water consumption landscape (e.g., plants and lawns) in residential design. Use native plants that do not require watering and are low ROG emitting.	O, GHG
R, C, I	Energy efficiency	Provide and require the use of battery powered or electric landscape maintenance equipment for new development.	O, GHG
C, I	Energy efficiency	Use clean engine technologies (e.g., alternative fuel, electrification) engines that are not subject to regulations.	O, DPM, GHG
R, C, I	Transportation	Provide and maintain a kiosk displaying transportation information in a prominent area accessible to employees and patrons.	O, P, GHG
R, C, I	Transportation	Develop recreational facility (e.g., parks, gym, pool, etc.) within one-quarter of a mile from site.	O, P, GHG
R, C, I	Transportation	If the project is located on an established transit route, provide improved public transit amenities (i.e., covered transit turnouts, direct pedestrian access, covered bench, smart signage, route information displays, lighting etc.).	O, P, GHG
R, C, I	Transportation	Project provides a display case or kiosk displaying transportation information in a prominent area accessible to employees or residents.	O, P, GHG
R, C, I	Transportation	Provide electrical charging station for electric vehicles.	O, P, GHG
R, C, I	Transportation	Provide neighborhood electric vehicles / car share program for the development.	O, P, GHG
R, C, I	Transportation	Provide bicycle-share program for development.	O, P, GHG
R, C, I	Transportation	Provide preferential parking / no parking fee for alternative fueled vehicles or vanpools.	O, P, GHG
R, C, I	Transportation	Provide bicycle lockers for existing 'Park and Ride' lots where absent or insufficient.	O, P, GHG
R C I	Transportation	Provide vanpool, shuttle, mini bus service (alternative fueled preferred).	O, P, DPM, GHG
C, I	Transportation	Provide secure on-site bicycle indoor storage, lockers, or racks.	O, P, GHG
C, I	Transportation	For large developments, provide day care facility on site.	O, P, GHG
C, I	Transportation	Provide on-site bicycle parking both short term (racks) and long term (lockers, or a locked room with standard racks and access limited to bicyclist only) to meet peak season maximum demand. One bike rack space per 10 vehicle/employee space is recommended.	O, P, GHG
C, I	Transportation	On-site eating, refrigeration and food vending facilities	O, P, GHG
C, I	Transportation	Implement a Transportation Choice Program to reduce employee commute trips. The applicant shall work with Rideshare for free consulting services on how to start and maintain a program.	O, P, GHG
C, I	Transportation	Provide incentives (e.g., bus pass, "Lucky Bucks", etc.) to employees to carpool/vanpool, take public transportation, telecommute, walk bike, etc.	O, P, GHG
C, I	Transportation	Implement compressed work schedules (i.e., 9–80s or 4–10s).	O, P, GHG
C, I	Transportation	Implement a telecommuting program.	O, P, GHG
C, I	Transportation	Implement a lunchtime shuttle to reduce single occupant vehicle trips.	O, P, GHG

LAND USE **Residential (R)** **Commercial (C)** **Industrial (I)**	**Measure Type**	**MITIGATION MEASURE**	**POLLUTANT REDUCED** **Ozone (O)** **Particulate (P)** **Diesel Particulate Matter (DPM)** **Greenhouse Gas (GHG)**
C, I	Transportation	Include teleconferencing capabilities, such as web cams or satellite linkage, which will allow employees to attend meetings remotely without requiring them to travel out of the area.	O, P, DPM, GHG
C, I	Transportation	If the development is or contains a grocery store or large retail facility, provide customers home delivery service in clean fueled vehicles	O, P, DPM, GHG
C, I	Transportation	At community event centers (i.e., amphitheaters, theaters, and stadiums) provide valet bicycle parking.	O, P, GHG
C, I	Transportation	Implement a "No Idling" program for heavy-duty diesel vehicles, which includes signage, citations, etc.	DPM, GHG
C, I	Transportation	Develop satellite work sites.	O, GHG
C, I	Transportation	Require the installation of electrical hookups at loading docks and the connection of trucks equipped with electrical hookups to eliminate the need to operate diesel-powered TRUs at the loading docks.	DPM, GHG
C, I	Transportation	If not required by other regulations (ARB's on-road or off-road diesel), restrict operation to trucks with 2007 model year engines or newer trucks.	O, DPM, GHG
C, I	Transportation	If not required by other regulations (ARB's on-road or off-road diesel), require or provide incentives to use diesel particulate filters for truck engines.	DPM
R	Transportation	Provide storage space in garage for bicycle and bicycle trailers, or covered racks / lockers to service the residential units.	O, P, GHG
R	Transportation	Provide free-access telework terminals and/or wi-fi access in multi-family projects.	O, P, GHG
C	Transportation	Develop core commercial areas within 1/4 to 1/2 miles of residential housing or industrial areas.	O, P, GHG

3.8.3 Off-Site Mitigation

Operational phase emissions from large development projects that cannot be adequately mitigated with on-site mitigation measures alone will require off-site mitigation in order to reduce air quality impacts to a level of insignificance if emissions cannot be adequately mitigated with on-site mitigation measures alone. Whenever off-site mitigation measures are deemed necessary, it is important that the developer, lead agency and APCD work together to develop and implement the measures to ensure successful outcome. This work should begin at least six months prior to issuance of occupancy permits for the project.

The first step in determining whether off-site mitigation is required is to compare the estimated operational phase emissions to the APCD significance thresholds. If the sum of ROG + NO_x emissions exceeds 25 tons/year, off-site mitigation will be required. Off-site mitigation may also be required for development projects were emissions exceed the 25 lb/day threshold. Examples of projects potentially subject to off-site mitigation include rural subdivisions, drive-through facilities and commercial development located far from the urban core.

If off-site mitigation is required, potential off-site mitigation measures may be proposed and implemented by the project proponent following APCD approval of the appropriateness and effectiveness of the proposed measure(s). Alternatively, the project proponent can pay a mitigation fee based on the amount of emission reductions needed to bring the project impacts below the applicable significance threshold. The APCD shall use these funds to implement a mitigation program to achieve the required reductions. The following outlines how to calculate the amount of off-site mitigation fees required for a given project:

a. Calculate the operational phase emissions for the project using CALEEMOD, or an equivalent calculation tool approved by the APCD; include the emission reduction benefits of any onsite mitigation measures included in the project. Any project emissions calculated to be above the APCD significance thresholds are defined as excess emissions and must be reduced below the emission thresholds by off-site mitigation.

b. Project emissions above the lbs/day threshold must be converted to tons/year and divided by the daily-to-annual equity ratio value of 5.5 to obtain an equivalent tons/year value.

c. The excess tons/year emissions are then multiplied by the project life (i.e., 50 years for residential projects and 25 years for commercial projects) and the most current cost-effectiveness[6] value as approved for the Carl Moyer grant program.

Off-site emission reductions can result from either stationary or mobile sources, but should relate to the on-site impacts from the project in order to provide proper "nexus" for the air quality mitigation. For example, NO_x emissions from increased vehicle trips from a large residential development could be reduced by funding the expansion of existing transit services in close proximity to the development project to reduce NO_x emissions. An off-site mitigation strategy should be developed and agreed upon by all parties prior to the start of construction.

The off-site mitigation strategies include but are not limited to the list provided below:

- Develop or improve park-and-ride lots;
- Retrofit existing homes in the project area with APCD-approved natural gas combustion devices;
- Retrofit existing homes in the project area with energy-efficient devices;
- Retrofit existing businesses in the project area with energy-efficient devices;
- Construct satellite worksites;
- Fund a program to buy and scrap older, higher emission passenger and heavy-duty vehicles.
- Replace/repower transit buses;
- Replace/repower heavy-duty diesel school vehicles (i.e. bus, passenger or maintenance vehicles);
- Fund an electric lawn and garden equipment exchange program;
- Retrofit or repower heavy-duty construction equipment, or on-road vehicles;
- Install bicycle racks on transit buses;
- Purchase Verified Diesel Emission Control Strategies (VDECS) for local school buses, transit buses or construction fleets;
- Install or contribute to funding alternative fueling infrastructure (i.e. fueling stations for CNG, LPG, conductive and inductive electric vehicle charging, etc.);
- Fund expansion of existing transit services;
- Fund public transit bus shelters;
- Subsidize vanpool programs;
- Subsidize transportation alternative incentive programs;
- Contribute to funding of new bike lanes;
- Install bicycle storage facilities; and,

6 Cost-effectiveness is a measure of the dollars needed to reduce a ton of emissions. The cost-effectiveness used to calculate off-site mitigation is based on the Carl Moyer Grant Program and is updated on a periodic basis. The Carl Moyer cost effectiveness value as of 2009 is $16,000 per ton. There will be a 10% administration fee charged for grant administration.

- Provide assistance in the implementation of projects that are identified in city or county Bicycle Master Plans.

3.9 EVALUATION OF PROJECT CHANGES

If the scope or project description is modified after final project approval, the project will need to be re-evaluated by the APCD to determine if additional air quality impacts will result from the proposed modifications. If additional impacts are expected, the cumulative impacts from the total project must be evaluated.

3.10 MITIGATION MONITORING

In order to ensure the operational phase air quality mitigation measures and project revisions identified in the EIR or mitigated negative declarations are implemented, the APCD may conduct site visits to ensure that the mitigation measures are fully implemented. The lead agency may also review project mitigation for consistency with project conditions. Beyond verifying mitigation implementation, this monitoring can result in compliance requirements if mitigation measures are not sufficiently being implemented.

4 TECHNICAL APPENDICES

4.1 BUILDING PERMIT REQUIREMENTS FOR FACILITIES POTENTIALLY SUBJECT TO AIR DISTRICT PERMITS

WHAT IS THE SAN LUIS OBISPO COUNTY AIR POLLUTION CONTROL DISTRICT?

The San Luis Obispo County Air Pollution Control District (APCD) regulates stationary sources of air pollution such as factories, industrial sites, and gasoline stations. APCD regulations apply to many manufacturing and industrial procedures as well as such things as evaporative compounds, gasoline, paint, odors, incineration, smoke and open burning.

Government Code section 65850.2 identifies certain air pollution information that cities and counties are required to collect for new building and development projects. Sections 42301.6 to 42301.9 (AB 3205) of the California Health & Safety Code address the release of hazardous air contaminants near schools, and discuss requirements for air district permits for new or modified facilities.

The following overview describes how the law may affect you.

NEW BUILDING PERMIT REQUIREMENTS

Under the law, final certificates of occupancy may not be issued unless certain requirements are met. One of the requirements is that all applicants must comply with APCD permit regulations, or make a showing to the APCD that the permit regulations do not apply to their particular project.

A questionnaire will accompany all building permit application packets distributed by City and County Planning and Building Departments. This questionnaire pertains to facility location and equipment, processes, and materials which may require an APCD permit This questionnaire should be completed and returned to the Planning and Building Department for initial screening and processing. If an APCD permit is required, and if air emissions occur within 1000 ft. of a school, focused notification of nearby residents and student's parents may be required.

All planning and building departments have a description of typical facility types, processes, and equipment that require an APCD Permit to Operate. The table at the back of the attached questionnaire provides a list of these facilities. Operations which usually require an APCD Permit include:

- Solvent cleaners (degreasers)
- Coating of metal parts and products
- Printing and coating operations
- Auto body shops
- Paint spray booths
- Storage of organic liquids
- Wood furniture and cabinet coating
- Air pollution control equipment
- Gasoline stations or any gasoline dispensing facility
- Sandblasting
- Equipment which handles asbestos, beryllium, benzene, hexavalent chromium, mercury, or vinyl chloride.
- Other solvent uses

It should be noted that all residential construction is exempt from these requirements.

If you are unsure whether or not your project is subject to permit requirements, the necessary information can be obtained by contacting the APCD and describing the proposed project. APCD staff can then determine if an application must be filed.

REQUIREMENTS FOR EXISTING OR PROPOSED PROJECTS NEAR SCHOOLS

Under the California Health and Safety Code, there are specific requirements which must be met by both the APCD and existing or proposed commercial or industrial facilities near a school.

Upon receipt of the facility operations questionnaire, the APCD will evaluate it for equipment or processes requiring a permit and for proximity to sensitive receptors. This initial screening will occur within fourteen (14) days of receipt of the questionnaire. The APCD will notify the applicant and the planning agency if further action is necessary under the law and/or the APCD permit process. If no further action is required, then the APCD will sign off on the questionnaire and return it to the Planning Agency. If hazardous materials may be used at the facility, APCD will also forward it to the Environmental Health Department or, for projects located within the City of San Luis Obispo, the San Luis Obispo Fire Department. If additional action is required under the law or the APCD permitting process, a description of required actions will be included in the letter sent to the planning department and the applicant.

CONSTRUCTION OF NEW SCHOOLS

For construction of new schools, **any person or agency preparing an Environmental Impact Report for a proposed school site must consult with the city, county, and the APCD to identify facilities within one-quarter mile of the proposed school site which may emit hazardous air emissions, or have the potential to explode or catch fire.** The city, county, and APCD have 30 days to provide this information to the person or agency seeking it. This requirement is spelled out in the Public Resources Code Sec. 21151.8, Subd.(a) (4).

FORESEEABLE THREAT OF RELEASE OF HAZARDOUS AIR CONTAMINANT

Under certain conditions, the law requires the APCD to take action when there is a reasonable threat of release of a hazardous air contaminant. APCD action is required if:

1. The release is predicted from a facility located within 1000 feet of a school; <u>and</u>

2. The release has the potential to impact persons at the school to the extent that a public health threat or nuisance could result.

When the release of a hazardous air contaminant is forecast, the APCD must notify the agency responsible for administering the hazardous materials policy. In addition, the APCD may respond to this reasonable threat of release by:

1. Issuing an immediate order to prevent the release; <u>or</u>,

2. Mitigating the foreseeable threat of a release, pending a hearing; <u>or</u>,

3. Applying to the APCD Hearing Board for issuance of an Order of Abatement.

Furthermore, if the principal of a school contacts the APCD to request an investigation of odors or possible air pollution sources as the cause of illness among school children, within 24 hours the APCD must respond and notify the city or county official responsible for administering hazardous materials policy and the fire department having jurisdiction over the school.

FOR HELP

This handout provides answers to commonly asked questions about new building permit and occupancy requirements. If you need additional information regarding these requirements, please call (805) 781- 5912.

SLO COUNTY apcd | Air Pollution Control District San Luis Obispo County

FACILITY OPERATIONS QUESTIONNAIRE

For the Incorporated and Unincorporated Areas of San Luis Obispo County

State law (AB 3205) requires an applicant for a commercial/industrial development project, building permit or occupancy permit to provide information to the Air Pollution Control District (APCD) indicating whether hazardous materials or certain equipment or processes will be used in or at the facility. Such uses may require a permit from the APCD and/or a Hazardous Materials Business Plan. **This law prohibits a City or County from issuing a final certificate of occupancy until the applicant or future building occupant has complied with the provisions of the law.** The law may also impose certain public noticing requirements for a facility that handles hazardous materials and is located within 1,000 feet of the outer boundary of a school (kindergarten through 12th grade). Additional information explaining the requirements of this law is attached to this form.

TO DETERMINE WHETHER YOUR BUSINESS IS SUBJECT TO THESE REQUIREMENTS, PLEASE COMPLETE THIS QUESTIONNAIRE:

Business Name (Doing Business As):	Contact Person:	Phone ( )	
Mailing Address:	City	State	Zip
Nearest Cross Streets:			

		YES	NO
1.	WILL THE INTENDED OCCUPANT(S) INSTALL OR USE ANY PIECE OF EQUIPMENT LISTED ON THE ATTACHED LIST? *(If YES forward to Air Pollution Control District.)*	☐	☐
2.	WILL THE INTENDED OCCUPANT(S) STORE, HANDLE OR USE ANY HAZARDOUS MATERIALS LISTED ON THE ATTACHED LIST? *(If YES forward to Air Pollution Control District.)*	☐	☐

Briefly Describe Nature of the Intended Business Activity:

Name of Owner or Authorized Agent:	Title:

I declare under penalty of perjury that, to the best of my knowledge and belief, the responses made herein are true and correct:	Agency Project ID Number: .
Signature of Owner or Authorized Agent: Signed: ______________________________ Date:______________________	Multiple or Unknown Occupants ☐ Check if Applicable

FOR PLANNING DEPARTMENT USE ONLY

	YES	NO	
Forwarded to APCD for processing:	☐	☐	Planning Dept. Official ____________________________________ Date ____________

FOR APCD USE ONLY

	YES	NO	FORWARDED TO:	YES	NO
APCD permit required	☐	☐	ENV. HEALTH	☐	☐
Potential hazardous materials	☐	☐	S.L.O. CITY FIRE	☐	☐
Within 1000' of a school	☐	☐			
Public notice required	☐	☐			

PROCESSED AND RETURNED TO PLANNING DEPARTMENT BY:	**FINAL** CHECK-OFF
Air Pollution Control District Official Date	Planning Department Official Date

PERMIT CATEGORIES

Businesses with the following equipment, operations or materials will require clearance from the Air Pollution Control District before obtaining a Certificate of Occupancy. Businesses which store, handle, or use hazardous materials will require clearance from the San Luis Obispo City Fire Department or San Luis Obispo County Environmental Health before obtaining a Certificate of Occupancy.

CHEMICALS
Ethylene Oxide Sterilizers
Acid Chemical Milling
Evaporators, Dryers, and Stills
Processing Organic Materials
Dry Chemical Mixing and storage

COATINGS AND SURFACE PREPARATION
Abrasive Blasting Equipment
Coating and Painting (not house-painting)
Paint, Stain, and Ink Manufacturing
Printers

COMBUSTION
Piston Internal Combustion Engines (50 hp or larger)
Incinerators and Crematories
Boilers and Heaters (2 million BTU/hr or larger)

ELECTRONICS
Solder Levelers
Wave Solder Machines
Vapor Degreasers
Fume Hood Scrubbers
Electrolytic Plating
Silicone Chip Manufacturing

FOOD
Smokehouses
Feed and Grain Mills
Coffee Roasters
Bulk Flour and Grain Storage

METALS
Metal Melting Devices
Hot Dip Galvanizing
Cadmium or Chrome Plating
Chromic Acid Anodizing

PETROLEUM FUELS MARKETING
Gasoline and Alcohol Bulk Plants and Terminals
Gasoline and Alcohol Fuel Dispensing

ROCK AND MINERAL
Hot Asphalt Batch Plants
Sand, Rock, and Aggregate Plants
Concrete Batch, Concrete Mixers, and Silos
Brick Manufacturing

SOLVENT USE
Vapor and Cold Degreasing
Solvent and Extract Dryers
Dry Cleaning

OTHER
Asphalt Roofing Tanks
Aqueous Waste Neutralization
Landfill Gas Flare or Recovery Systems
Waste Disposal and Reclamation Units
Grinding Booths and Rooms
Oil Field Exploration or Production
Plastic/Fiberglass Manufacturing
Soil Aeration/Reclamation
Storage of Organic Liquids
Powder Coating
Fiberglass Chopper Guns
Waste Water Treatment Works

EXAMPLES OF HAZARDOUS MATERIALS

Ammonia
Acids and Bases
Chlorine
Compressed Gases
Corrosives
Cryogenic Fluids
Explosives
Fertilizers
Flammable Liquids and Solids
Gasoline
Hazardous Material Mixtures
Herbicides
Industrial Cleaners
Infectious/Biological Materials
Oxidizing Materials
Paint Thinners
Paints
Pesticides
Petroleum Products
Poisons
Pyrophoric/Hypergolic Materials
Radioactives
Solvents
Waste Oils
Water Reactives
Welding Gases

NOTE: Other equipment not listed here that is capable of emitting air contaminants may require a San Luis Obispo County Air Pollution Control District Permit. If there are any questions, contact the APCD at (805) 781-5912. For information on Hazardous Materials located within the City of San Luis Obispo contact the San Luis Obispo Fire Department at (805) 781-7380. All other areas contact County Environmental Health at (805) 781-5544.

IF YOU INSTALL AND/OR OPERATE EQUIPMENT WITHOUT A REQUIRED PERMIT, YOU MAY BE SUBJECT TO LEGAL ACTION AND PENALTIES OF UP TO $50,000 PER DAY FOR EACH DAY OF VIOLATION

TIMELINE AND IMPLEMENTATION PROCESS

I. Outside Agency (Planning Department) Responsibilities

A. Planning Department distributes Development Plan (DP) Application Packet to applicant. This packet includes AB3205 information.

B. Applicant completes the DP packet, and returns it to the Planning Department.

C. Planning Department conducts **initial screening** of Hazardous Materials Questionnaire (hereafter referred to as the Questionnaire). This screening consists of reviewing the Questionnaire for answers to the following questions:

1. Will the intended occupant(s) install or use any of the equipment listed on attached list ("San Luis Obispo County APCD Permit Categories").

2. Will the intended occupant store, handle, or use hazardous materials in any quantity?

D. The Planning Department performs one of the following actions, based on the response to the questions listed in Section I.C. above:

1. If the answers to Questions #1 and #2 are **NO**, then this project is exempt from AB3205 requirements, and from APCD permitting action. The Planning Department can sign off on the Questionnaire, indicating that the project is exempt from further action under AB3205. This questionnaire is then retained as part of the project file maintained by the Planning Department.

2. If the answer to either Question #1 or Question #2 is **YES**, the questionnaire is forwarded to the APCD for further review.

II. APCD Responsibilities

APCD reviews the Questionnaires received from the Planning Department. Within 14 days, one of the following determinations will be made:

A. If the answer to question 1 on the Facility Operations Questionnaire is **NO** and the APCD agrees, complete the appropriate boxes on the rest of the form and return to the Planning Department.

B. If the answer to question 1 on the Facility Operations Questionnaire is **NO** but the APCD disagrees, continue to sections C and D below.

C. APCD Permit Required/Exempt from AB3205 Requirements.

If the answer to Question #1 is **YES**, and the facility is not located within 1000 feet of a school, then the project is exempt from further processing under AB3205, but **IS** subject to APCD permitting requirements. As a result, the APCD will take the following actions:

Within 7 days of receipt of the questionnaire from the Planning Department, the APCD will:

- Review the Questionnaire to determine if the source stores, handles or uses hazardous materials (Question #2 on the form). If the answer to that question is **YES**, then APCD completes the appropriate sections of the questionnaire and forwards it to either the City of San Luis Obispo Fire Department (if project is within the City limits), or Environmental Health (all other areas). A memo to County Planning will be sent summarizing action taken.

- If Hazardous Materials storage, usage or handling is not proposed on-site, APCD Planning Staff will indicate that on the questionnaire. The "APCD Permit Required" box will be checked "YES", and the form returned to the Planning Department.

The APCD Engineering Staff sends a letter to the project applicant indicating that this project **IS** subject to APCD permit. Accompanying this letter will be an ATC (Authority to Construct) application, and other explanatory information.

Upon receipt of an ATC application, the APCD has 30 days to determine if the application is complete. A letter of completeness (or incompleteness) is sent to the applicant prior to the end of the 30-day period. If the application is incomplete, the APCD will request additional information in the aforementioned letter. If the application is complete, then the APCD will issue a completeness letter indicating that they have 180 days to issue an ATC.

After project construction is complete, the applicant must indicate in writing to the APCD that construction is complete. A field inspection will then be conducted by APCD staff to determine compliance with applicable APCD Rules and Regulations. Upon verification of compliance, a Permit-to-Operate (PTO) for the subject facility is issued by the APCD.

D. APCD Permit Required/Subject to AB3205 Requirements

If the answer to Questions #1 is **YES,** and the facility is within 1000 feet of a school, the proposed project will be subject to the APCD permitting process and AB3205 Public Noticing Requirements. The APCD will perform the following actions:

Within 7 days of receipt of the questionnaire from the Planning Department, the APCD will:

- Review the Questionnaire to determine if the source stores, handles or uses hazardous materials (Question #2 on the form). If the answer to that question is **YES**, then APCD completes the appropriate sections of the questionnaire and forwards it to either the City of San Luis Obispo Fire Department (if project is within the City limits), or Environmental Health (all other areas). A memo to County Planning will be sent summarizing action taken.

- If Hazardous Materials storage, usage, or handling is not proposed on-site, APCD Planning Staff will indicate as such on the questionnaire.

The APCD Engineering Staff sends a letter to the project applicant indicating that this project **IS** subject to APCD permit and AB3205 Public Noticing requirements. Accompanying this letter will be an ATC application, a description of public noticing requirements and other explanatory information.

Upon receipt of an ATC application, the APCD has 30 days to determine if the application is complete. A letter of completeness (or incompleteness) is sent to the applicant prior to the end of the 30-day period. If the application is incomplete, the APCD will request additional information in the aforementioned letter.

When the APCD has deemed the ATC application complete, the applicant will then be required to comply with the public noticing requirements of the California Health and Safety Code, Section 42301.6. Compliance with the public noticing requirements must be demonstrated prior to APCD action on the ATC application. These requirements are as follows:

- The Air Pollution Control Officer (APCO) shall, **at the expense of the permit applicant**, distribute (or mail) a public notice to the parents or guardians of children enrolled in ANY school that is located within 1/4 mile of the proposed project site, and to each address within a 1000 ft. radius of the proposed source. An assessor's parcel map will be used to determine the area encompassing addresses within the 1000 ft. radius of the proposed project.

- The public noticing period extends for 30 days, and MUST begin at least 30 days prior to the APCD taking final action on the ATC application for the proposed project. This notice may be combined with any other notice on the project or permit, which is required by law. The APCO shall review and consider all public comments received during the 30 days after the notice is distributed, and shall include written responses to the comments in the permit application file prior to taking final action on the application.

State law requires the APCD to approve or deny the ATC within 180 days of the date on which the A/C application was deemed complete. The public noticing period and the APCD response to public comments MUST occur within this time period. The APCD cannot issue the ATC until public noticing requirements for AB3205 have been satisfied.

After project construction is completed, the applicant must indicate **in writing** to the APCD that construction is complete. A field inspection will then be conducted by APCD staff to determine compliance with applicable APCD Rules and Regulations. Upon verification of compliance, a PTO or the subject facility is issued by the APCD.

4.2 ARB'S RECOMMENDATIONS ON SITING NEW SENSITIVE LAND USES [7]

Table 4-1: Siting New Sensitive Land Use

Source Category	Advisory Recommendations
Freeways and high-traffic roads	• Avoid siting new sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles per day.
Distribution centers	• Avoid siting new sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating transport refrigeration units (TRUs) per day, or where TRU unit operations exceed 300 hours per week). • Take into account the configuration of existing distribution centers and avoid locating residences and other new sensitive land uses near entry and exit points.
Railyards	• Avoid siting new sensitive land uses within 1,000 feet of a major service and maintenance rail yard. • Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	• Avoid siting of new sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult the Air District or the ARB on the status of pending analyses of health risks.
Refineries	• Avoid siting new sensitive land uses immediately downwind of petroleum refineries. Consult with local air districts and other local agencies to determine an appropriate separation.
Chrome platers	• Avoid siting new sensitive land uses within 1,000 feet of a chrome plater.
Dry cleaners using perchloroethylene	• Avoid siting new sensitive land uses within 300 feet of any dry cleaning operation. For operations with two or more machines, provide 500 feet. For operations with 3 or more machines, consult with the local air district. • Do not site new sensitive land uses in the same building with perchloroethylene • dry cleaning operations.
Gasoline dispensing facilities	• Avoid siting new sensitive land uses within 300 feet of a large gas station (defined as a facility with a throughput of 3.6 million gallons per year or greater). A 50 foot separation is recommended for typical gas dispensing facilities.

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- These recommendations are advisory. Land use agencies have to balance other considerations, including housing and transportation needs, economic development priorities, and other quality of life issues.
- Recommendations are based primarily on data showing that the air pollution exposures addressed here (i.e., localized) can be reduced as much as 80% with the recommended separation.
- The relative risk for these categories varies greatly. To determine the actual risk near a particular facility, a site-specific analysis would be required. Risk from diesel PM will decrease over time as cleaner technology phases in.
- These recommendations are designed to fill a gap where information about existing facilities may not be readily available and are not designed to substitute for more specific information if it exists. The recommended distances take into account other factors in addition to available health risk data (see individual category descriptions).
- Site-specific project design improvements may help reduce air pollution exposures and should also be considered when siting new sensitive land uses.
- This table does not imply that mixed residential and commercial development in general is incompatible. Rather it focuses on known problems like dry cleaners using Perchloroethylene that can be addressed with reasonable preventative actions.
- A summary of the basis for the distance recommendations can be found in the ARB Handbook.

4.3 APCD-APPROVED DUST SUPPRESSANTS

The following list of dust control suppressants are approved by the SLO County APCD. The approved suppressants must be reapplied at a frequency that ensures that fugitive dust emissions are adequately controlled to below the 20% opacity limit identified in the APCD Rule 401 *Visible Emissions* and to ensure that dust is not emitted offsite. If fugitive dust is not adequately controlled, emissions could result in complaints and a violation of APCD Rule 402 *Nuisance*. The APCD will consider products that are not listed on a case-by-case bases; provide product specifics to APCD by contacting the APCD Planning Division at (805) 781-5912.

Suppressants are often used in combination with other APCD recommended control methods to minimize fugitive dust emissions. Other methods include:

1) Paving and then maintaining to applicable standards thus replacing need for suppressants and other control methods;
2) Implementing and maintaining design standards to ensure vehicles speeds on unpaved areas are physically limited to a posted speed limit of 15 mph or less; and
3) For special events, site parking areas in grass or low cut dense vegetative areas that are adequately irrigated to minimize fugitive dust emissions.

SLO County APCD used a 2002 San Joaquin Valley APCD [1] list of dust suppressants as the starting point for the list presented below. Products that could not be readily found were removed from the list. This SLO County APCD list also streamlines the SJVAPCD list by removing hygroscopic products and all but one of the petroleum based products from the SJVAPCD list. A petroleum based method (chipseal) and three polymer products (Dust Binder, Gorilla-Snot, and Soiltac) were added to the list.

Any chemical or organic material used for stabilizing solids shall not violate the California State Water Quality Control Board standards for use as a soil stabilizer. Any dust suppressant must not be prohibited for use by the US Environmental Protection Agency, the California Air Resources Board, or other applicable law, rule, or regulation.

Table 4-2: Approved Dust Suppressants

Suppressant Category	Suppressant Sub-Category	Product Common Name	Company	Product Web Link
Adhesives	Lignosulfonate	• CalBinder	California-Fresno Oil Co. (209) 486-0220	www.calfresno.com
		• DC-22	Dallas Roadway Products, Inc. SALS Roadway Products (972) 758-7454	www.dallasroadway.com www.salsroadproducts.com
		• Dustac, Dustac-100	Georgia Pacific (866) 447-2436, (800) 283-5547	www.gp.com/chemical
		• Lignin LS-50™	Prince Minerals, Inc. (646) 747-4200	www.princeminerals.com/products/dust_control.php
		• Lignosulfonate	EnviroTech Services (800) 369-3878	www.envirotechservices.com
		• Polybinder	Jim Good Marketing (805) 746-3783	-
	Calcium Lignosulfonate	• Calcium Lignin LS-50™	Prince Minerals, Inc. (646) 747-4200	www.princeminerals.com/products/dust_control.php
		• Dustac® Road Binder	Quatsino Navigation Co. Ltd (916) 442-9089	http://www.bellmarine.com/Dustac.htm
Petroleum Emulsions	-	• PennzSuppress-D **[2]**	PennzSuppress® Dust Suppressant American Refining Group, Inc. (814) 368-1200	www.arb.ca.gov/eqpr/pennzoil/pennzoil.htm
Polymer	-	• DC-1000	Desert Mountain (505) 598-5730	www.desertmtncorp.com
		• Dust Binder	Monterey AgResources (559) 499-2100	www.montereyagresources.com

Suppressant Category	Suppressant Sub-Category	Product Common Name	Company	Product Web Link
		• Earthbound, Earthbound L	Earth Chem, Inc. (800) 764-5726	www.earthchem.com
		• Liquid Dust Control	Enviroseal Corporation (800) 775-9474	www.enviroseal.com/ldc.htm
		• Marloc	Reclamare Co. (206) 824-2385	-
		• PolyPavement	PolyPavement Company (323) 954-2240	www.polypavement.com
		• Soil Master WR	Environmental Soil Systems, Inc. (800) 368-4115	-
		• Soil Seal	Trans Western Chemicals, Inc. (562) 942-1833	www.soilseal.com
		• Soil Sement **[2]**	Midwest Industrial Supply, Inc. (800) 321-0699	www.arb.ca.gov/eqpr/midwest.htm
		• Soiloc-D	Hercules Soiloc (800) 815-7668	-
		• Soiltac or Gorilla-Snot	Soilworks, LLC (800) 545-5420	www.Soilworks.com
		• TerraBond PolySeal	Fluid Sciences, LLC (888) 356-7847	www.fluidsciences.com
		• Top Shield	Base Seal International, Inc. (800) 729-6985	www.baseseal.com
Oil-Rock Binding Agent	-	• Chipseal **[3]**	-	-

[1] Re: www.valleyair.org/busind/comply/PM10/Products%20Available%20for%20Controlling%20PM10%20Emissions.htm

[2] "Pre-certified" by the California Air Resources Board; www.arb.ca.gov/eqpr/eqpr.htm

[3] Though chipseal is typically used as a sealant for paved roads, it can also be an effective dust suppressant on unpaved private roads. Project proponents accept liability of potential vehicle or property damage associated with this dust control method.

4.4 SLO COUNTY NATURALLY OCCURRING ASBESTOS MAP

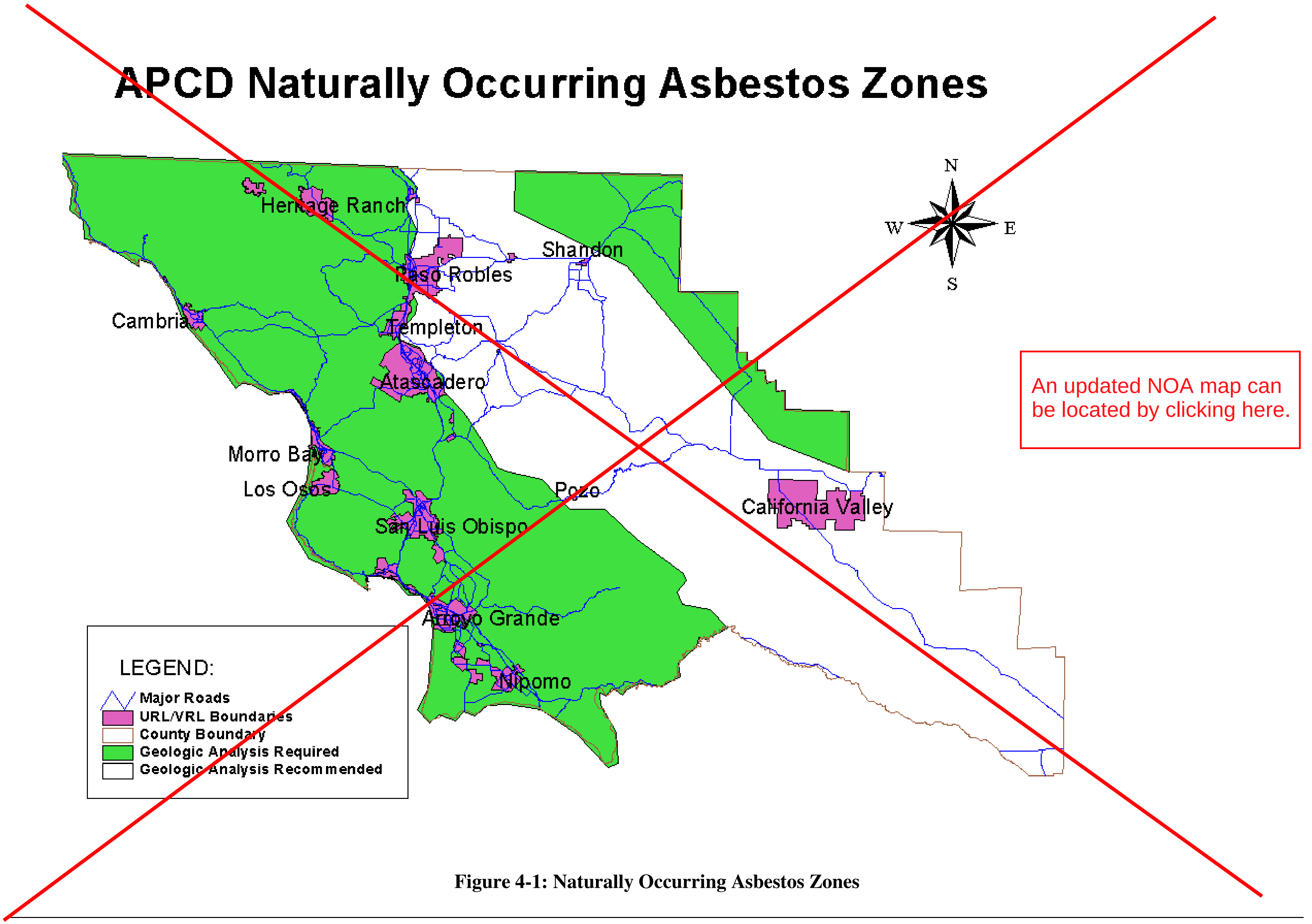

Figure 4-1: Naturally Occurring Asbestos Zones

4.5 CONSTRUCTION ACTIVITY MANAGEMENT PLAN GUIDELINES

A Construction Activity Management Plan (CAMP) may be required by the Air Pollution Control District (APCD) for construction projects that will result in significant particulate matter (PM) and/or nitrogen oxide (NO_x) emission impacts, such as potentially high emissions of fugitive dust or NO_x, or emissions in areas where potential nuisance concerns are present. The purpose of the CAMP is to specifically define the mitigation measures that will be employed as the project moves forward, in order to ensure all requirements are accounted for in the project budget, included in the contractor bid specifications, and are fully implemented throughout project construction.

The following information is provided as a guide for development of the CAMP. Specific implementation of mitigation measures will vary from project to project. **The CAMP is a comprehensive mitigation plan and will need to specifically identify all of the mitigation measures to be implemented for the project.** The following is a list of potential mitigation measures to include in the CAMP. The CAMP must be submitted to the APCD for approval prior to the start of the project.

Prior to commencement of any construction activities (e.g., site preparation, grading or construction activities) the applicant will notify the appropriate planning agency and the APCD, by letter, of the status of the air quality measures outlined in the CAMP. The letter will state the following: 1) the controls that will be implemented; 2) the reasons why any unimplemented measures are considered infeasible and the measures incorporated to substitute for these measures; 3) when scheduled construction activities will be initiated to allow for APCD inspection of the mitigation measures.

- **<u>SENSITIVE RECEPTORS (NOx and PM)</u>**
  The proximity of the project to the nearest residence and to the nearest sensitive receptor (e.g. school, daycare, hospital or senior center) needs to be documented and the mitigation measures outlined in the CAMP need to be tailored accordingly to provide adequate protection to any nearby sensitive receptors. (e.g. of mitigation measures: Locate construction staging areas away from sensitive receptors such that exhaust and other construction emissions do not enter the fresh air intakes to buildings, air conditioners, and windows).

- **<u>MITIGATION MONITORING (NOx and PM)</u>**
  A person or persons must be designated to monitor the CAMP implementation. This person will be responsible for compliance with the CAMP. Their duties shall include holidays and weekend periods when work may not be in progress. Depending on the site location, a certified visible emissions monitor may be required. The name and telephone number of such persons shall be provided to the APCD prior to the start of any construction activities.

- **<u>DUST CONTROL (PM)</u>**
  Construction activities can generate fugitive dust, which could be a nuisance to local residents and businesses in close proximity to the proposed construction site. Dust complaints could result in a violation of the APCD's 402 "Nuisance" Rule. The following is a list of measures that may be required throughout the duration of the construction activities:
  a. Reduce the amount of the disturbed area where possible.
  b. Use of water trucks or sprinkler systems in sufficient quantities to prevent airborne dust from leaving the site. An adequate water supply source must be identified. Increased watering frequency would be required whenever wind speeds exceed 15 mph. Reclaimed (non-potable) water should be used whenever possible.
  c. All dirt stockpile areas should be sprayed daily as needed, covered, or an APCD approved alternative method will be used.
  d. Permanent dust control measures identified in the approved project revegetation and landscape plans should be implemented as soon as possible following completion of any soil disturbing activities.

e. Exposed ground areas that will be reworked at dates greater than one month after initial grading should be sown with a fast-germinating non-invasive grass seed and watered until vegetation is established.
f. All disturbed soil areas not subject to revegetation should be stabilized using approved chemical soil binders, jute netting, or other methods approved in advance by the APCD.
g. All roadways, driveways, sidewalks, etc. to be paved should be completed as soon as possible. In addition, building pads should be laid as soon as possible after grading unless seeding or soil binders are used.
h. Vehicle speed for all construction vehicles shall not exceed 15 mph on any unpaved surface at the construction site.
i. All trucks hauling dirt, sand, soil, or other loose materials are to be covered or should maintain at least two feet of freeboard (minimum vertical distance between top of load and top of trailer) in accordance with CVC Section 23114.
j. Install wheel washers where vehicles enter and exit unpaved roads onto streets, or wash off trucks and equipment leaving the site.
k. Sweep streets at the end of each day if visible soil material is carried onto adjacent paved roads. Water sweepers with reclaimed water should be used where feasible.

All PM_{10} mitigation measures required should be shown on grading and building plans. In addition, the contractor or builder should designate a person or persons to monitor the dust control program and to order increased watering, as necessary, to prevent transport of dust offsite. Their duties shall include holidays and weekend periods when work may not be in progress. **<u>The name and telephone number of such persons shall be provided to the APCD prior to land use clearance for map recordation and finished grading of the area.</u>**

- **<u>CONSTRUCTION PHASE GREENHOUSE GAS (GHG) EMISSION REDUCTIONS</u>**
  The Attorney General requires GHG impact evaluation and the implementation of feasible mitigation at the project level. As such, the project's Mitigated Negative Declaration should evaluate the project's carbon dioxide (CO_2) emissions as well as other GHG sources converted to carbon dioxide equivalents and should identify feasible mitigation that the project shall implement. The project's overall GHG impact evaluation should include:
  a. The short term GHG impacts from the construction phase amortized over the life of the project (50 years for residential or residential support facilities and 25 years for commercial or industrial facilities) to provide a mechanism for the project to mitigate these impacts by adding these amortized impacts to the operational phase impacts; and
  b. The project's operational phase GHG impacts.

  <u>For the construction phase (operational phase as well) feasible GHG mitigation measures to be implemented should be identified from the California Air Pollution Control Officer Association's (CAPCOA) January 2008 published document entitled "CEQA and Climate Change" or from other proven energy efficiency measures. The document is available online at:</u>
  <u>www.capcoa.org/CEQA/CAPCOA%20White%20Paper.pdf</u>
  <u>In some cases where the available measures are marginally effective, off-site GHG mitigation fees are appropriate</u>.

- **<u>CONSTRUCTION EQUIPMENT EMISSION REDUCTIONS (NOx and PM)</u>**
  To mitigate air quality impacts from the emissions of construction equipment engines, the APCD has project proponents apply various emission reduction methods depending on the magnitude of the project. Below are the methods used:

  <u>Standard Control Measures for Construction Equipment</u>
  The standard mitigation measures for reducing nitrogen oxide (NO_x), reactive organic gases (ROG), and diesel particulate matter (Diesel PM) emissions from construction equipment are listed below:
  (a) Maintain all construction equipment in proper tune according to manufacturer's specifications;
  (b) Fuel all off-road and portable diesel powered equipment with ARB certified motor vehicle diesel fuel (non-taxed version suitable for use off-road);

(c) Use diesel construction equipment meeting ARB's Tier 2 certified engines or cleaner off-road heavy-duty diesel engines, and comply with the State off-Road Regulation;
(d) Use on-road heavy-duty trucks that meet the ARB's 2007 or cleaner certification standard for on-road heavy-duty diesel engines, and comply with the State On-Road Regulation;
(e) Construction or trucking companies with fleets that that do not have engines in their fleet that meet the engine standards identified in the above two measures (e.g. captive or NO_x exempt area fleets) may be eligible by proving alternative compliance;
(f) All on and off-road diesel equipment shall not idle for more than 5 minutes. Signs shall be posted in the designated queuing areas and or job sites to remind drivers and operators of the 5 minute idling limit;
(g) Diesel idling within 1,000 feet of sensitive receptors is not permitted;
(h) Staging and queuing areas shall not be located within 1,000 feet of sensitive receptors;
(i) Electrify equipment when feasible;
(j) Substitute gasoline-powered in place of diesel-powered equipment, where feasible; and,
(k) Use alternatively fueled construction equipment on-site where feasible, such as compressed natural gas (CNG), liquefied natural gas (LNG), propane or biodiesel.

Best Available Control Technology (BACT) for Construction Equipment

If the estimated construction phase ozone precursor emissions from the actual fleet for a given Phase are expected to exceed the APCD's threshold of significances after the standard mitigation measures are factored into the estimation, then BACT needs to be implemented to further reduce these impacts. The BACT measures can include:

- Further reducing emissions by expanding use of Tier 3 and Tier 4 off-road and 2010 on-road compliant engines;
- Repowering equipment with the cleanest engines available; and
- Installing California Verified Diesel Emission Control Strategies. These strategies are listed at: http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm
- Implementing a design measure to minimize emissions from on and off-road equipment associated with the construction phase. This measure should include but not be limited to the following elements:
  - Tabulation of on and off-road construction equipment (type, age, horse-power, engine model year and miles and/or hours of operation);
  - Calculate daily worst case emissions and the quarterly emissions that include the overlapping segments of construction phases
  - Equipment Scheduling (NOx and PM)
    - Schedule activities to minimize the amount of large construction equipment operating simultaneously during any given time period;
    - Locate staging areas at least 1000 feet away from sensitive receptors;
    - Where feasible:
      - Limit the amount of cut and fill to 2,000 cubic yards per day;
      - Limit the length of the construction work-day period; and,
      - Phase construction activities.

On-Road Truck Management (NOx and PM)

- Schedule construction truck trips during non-peak hours to reduce peak hour emissions;
- Locate staging areas at least 1000 feet away from sensitive receptors;
- Proposed truck routes should be evaluated to define routing patterns with the least impact to residential communities and sensitive receptors and identify these receptors in the truck route map;
- To the extent feasible, construction truck trips should be scheduled during non-peak hours to reduce peak hour emissions; and
- Trucks and vehicles should be kept with the engine off when not in use, to reduce vehicle emissions. Signs shall be placed in queuing areas to remind drivers to limit idling to no longer than 5 minutes.

Offsite Mitigation for Construction Equipment

If the estimated construction phase ozone precursor emissions from the actual fleet for a given Phase are expected to exceed the APCD's 6 tons/quarter threshold of significance after the standard and BACT measures are factored into the estimation, then off-site mitigation is appropriate. The current mitigation rate is $16,000 per ton of ozone precursor emission (NO_x + ROG) over the APCD threshold evaluated over the length of the expected exceedance. The applicant may use these funds to implement APCD approved emission reduction projects near the project site or may pay that funding level plus a 15% administration fee to the APCD for the APCD to implement emission reduction projects in close proximity to the project. The applicant shall provide this funding at least two (2) months prior to the start of the project to help facilitate emission offsets that are real-time as possible.

- **CONSTRUCTION WORKER TRIPS (NOx)**
  Implement an APCD approved Trip Reduction Program to reduce construction worker commute trips, which includes carpool matching, vanpooling, transit use, etc. Monitor worker use of alternative transportation throughout the project to ensure compliance.

- **COMPLAINT RESPONSE (NOx and PM)**
  The CAMP should include a section that addresses complaints and complaint handling. At a minimum this section shall include the following:
  - The person(s) responsible for addressing and resolving all complaints regarding the construction activity and their contact information is:
    - Name(s)
    - Company and Title(s)
    - Phone numbers and physical address.
  - A hotline telephone number shall be established and publicized to help facilitate rapid complaint identification and resolution. In addition, Prop 65 notification with regard to toxic diesel emissions shall to be made.
  - An action plan section shall be outlined that includes additional measures or modifications to existing mitigation measures in the event of complaints.
  - All complaints shall be reported immediately to the APCD.

- **PERMITTING REQUIREMENTS**
  Portable equipment, 50 horsepower (hp) or greater, used during construction activities may require California statewide portable equipment registration (issued by the California Air Resources Board) or an APCD permit. Operational sources may also require APCD permits.
  The following list is provided as a guide to equipment and operations that may have permitting requirements, but should not be viewed as exclusive. For a more detailed listing, refer to page A-5 in the APCD's CEQA Handbook.
  - Power screens, conveyors, diesel engines, and/or crushers.
  - Portable generators 50 hp or greater
  - Chemical product processing and or manufacturing
  - Electrical generation plants or the use of standby generator
  - Food and beverage preparation (primarily coffee roasters)
  - Furniture and fixture products
  - Metal industries, fabrication
  - Small scale manufacturing
  - Auto and vehicle repair and painting facilities
  - Fuel dealers
  - Dry cleaning
  - Pipelines
  - Public utility facilities
  - Boilers
  - IC Engines
  - Sterilization units(s) using ethylene oxide and incinerator(s)
  - Cogeneration facilities

- Unconfined abrasive blasting operations
- Concrete batch plants
- Rock and pavement crushing
- Tub grinders trommel screens

To minimize potential delays, prior to the start of the project, please contact the APCD Engineering Division at (805) 781-5912 for specific information regarding permitting requirements.

- **SPECIAL CONDITIONS**

Naturally Occurring Asbestos
If the project site is located in a candidate area for Naturally Occurring Asbestos (NOA), which has been identified as a toxic air contaminant by the California Air Resources Board (ARB) the following requirements apply. Under the ARB Air Toxics Control Measure (ATCM) for Construction, Grading, Quarrying, and Surface Mining Operations, prior to any construction activities at the site, the project proponent shall ensure that a geologic evaluation is conducted to determine if NOA is present within the area that will be disturbed. If NOA is not present, an exemption request must be filed with the APCD. If NOA is found at the site the applicant must comply with all requirements outlined in the Asbestos ATCM. This may include development of an Asbestos Dust Mitigation Plan and an Asbestos Health and Safety Program for approval by the APCD. Please refer to the APCD web page at *http://www.slocleanair.org/business/asbestos.asp* for more information or contact the APCD Enforcement Division at (805) 781-5912.

Demolition of Asbestos Containing Materials
Demolition activities can have potential negative air quality impacts, including issues surrounding proper handling, demolition, and disposal of asbestos containing material (ACM). Asbestos containing materials could be encountered during demolition or remodeling of existing buildings. Asbestos can also be found in utility pipes/pipelines (transite pipes or insulation on pipes). If utility pipelines are scheduled for removal or relocation; or building(s) are removed or renovated this project may be subject to various regulatory jurisdictions, including the requirements stipulated in the National Emission Standard for Hazardous Air Pollutants (40CFR61, Subpart M - asbestos NESHAP). These requirements include but are not limited to: 1) notification requirements to the APCD, 2) asbestos survey conducted by a Certified Asbestos Inspector, and, 3) applicable removal and disposal requirements of identified ACM. Please contact the APCD Enforcement Division at (805) 781-5912 for further information.

Lead During Demolition
Demolition of structures coated with lead based paint is a concern for the APCD. Improper demolition can result in the release of lead containing particles from the site. Sandblasting or removal of paint by heating with a heat gun can result in significant emissions of lead. Therefore, proper abatement of lead before demolition of these structures must be performed in order to prevent the release of lead from the site. Depending on removal method, an APCD permit may be required. Contact the APCD Engineering Division at (805) 781-5912 for more information. Approval of a lead work plan by the APCD is required and must be submitted ten days prior to the start of the demolition. Contact the APCD Enforcement Division at (805) 781-5912 for more information. For additional information regarding lead removal, please contact Cal-OSHA at (805) 654-4581.

4.6 Qualified GHG Plan Level Guidance

This guidance is intended to assist local governments in developing community scale Climate Action Plans. In drafting this guidance, the San Luis Obispo County Air Pollution Control District (APCD) has drawn from established methodologies and practices, rather than creating new protocols or quantification methods. This guidance should be interpreted as recommended approaches rather than a formal protocol. This guidance will be continually updated as new tools, methodologies and protocols are developed and refined.

Any Climate Action Plan (CAP) that aims to support tiering of future development projects for purposes of CEQA review of GHG impacts must include these standard elements.

a. A community-wide GHG emissions inventory and "business-as-usual" forecast of year 2020 community-wide GHG emissions;
b. GHG reduction targets consistent with AB 32;
c. An analysis of local and state policies and actions that may impact GHG emissions within the jurisdiction;
d. Quantification of GHG reduction measures demonstrating that, if fully implemented, the GHG reduction targets will be met;
e. An implementation and monitoring strategy and timeline;
f. An adequate environmental review of the proposed CAP.

Early consultation with APCD staff is essential; the importance of communicating with District staff early in the climate planning process cannot be overemphasized. District staff is available to meet with local government planners, review methodologies, discuss approaches and any other issues throughout the process of preparing the CAP.

An environmental document that relies on a greenhouse gas reduction plan for a cumulative impacts analysis must identify those requirements specified in the plan that apply to the project; if those requirements are not otherwise binding and enforceable, they must be incorporated as mitigation measures applicable to the project. If there is substantial evidence that the effects of a particular project may be cumulatively considerable, notwithstanding its compliance with the specified requirements in the plan for the reduction of greenhouse gas emissions, an EIR must be prepared for the project.

<u>Qualitative Requirements for Qualified GHG Reduction Strategies</u>

1) The GHG emissions inventory should be complete and comprehensive

Any GHG emissions source addressed in this guidance should be included in the GHG inventory and forecast for the local CAP. If an emissions source is not included (for example, direct access electricity use or wastewater treatment), it should be clearly explained why that source was omitted. District staff will review this explanation as part of the evaluation of the CAP.

2) Calculations and assumptions should be transparent

It is important to emphasize that all methodologies and assumptions should be documented and explained within the CAP document.

3) GHG reduction strategies should rely primarily on mandatory measures

To date, most CAPs have emphasized voluntary GHG reduction measures over mandatory measures, indicated with language like "should promote," and "will encourage," etc. However, because implementation of voluntary measures cannot be guaranteed, their contribution to meeting the GHG reduction target is more speculative than that of mandatory measures. Problems that may result from over-reliance on voluntary measures include the following:

- It could be very difficult for local jurisdictions to demonstrate that GHG reduction targets are being met through voluntary measures.
- This, in turn, will make it difficult for a local government to determine if a project is complying with the adopted CAP in order to appropriately tier off of the CAP CEQA document.
- If the local government cannot document that its CAP is on track to achieve the GHG reduction

target, then the CAP may cease to comply with the "qualified" criteria. In this case subsequent projects would not be eligible to benefit from the tiering provisions of CEQA.

If voluntary measures are included in the CAP, distinctions should be drawn between those that are more or less likely to result in full implementation. For example, incentive-based programs (like AB 811 programs) are usually more likely to achieve results than outreach-based programs. Some CAPs have taken a cautious approach and have not quantified GHG reductions from the latter type of measure, due to their highly speculative nature. The APCD recommends only mandatory measures and strong voluntary measures (such as incentive-based programs) be quantified as contributing toward the GHG reduction target.

4) Build in a margin of safety

Once the CAP enters the implementation phase it is possible that unforeseen issues or obstacles may arise that prevent full implementation of all CAP measures, or the emission reductions achieved for some measures may be less than anticipated. These risks may be heightened by unforeseen economic or political developments that adversely affect implementation of the measures. Therefore, APCD recommends the CAP build in a margin of safety to ensure it can continue to serve as a defensible "Qualified GHG Reduction Strategy." This can be accomplished by:

- Including more GHG mitigation measures than needed to meet the GHG reduction target, thus creating a "buffer" against lower than anticipated results;
- Emphasizing mandatory over voluntary measures;
- Including contingency measures (with quantified emission reduction estimates) that can be activated to fill any gap needed to maintain the expected rate of progress toward achieving the emissions reduction target.

5) Measures should address existing as well as new development

The AB 32 target of reducing GHG emissions to 1990 levels by 2020 represents an initial step toward achieving the longer term goal of Executive Order S-3-05, which calls for reducing GHG emissions to 80% below 1990 levels by 2050; this equates to less than 2 metric tons of GHGs per capita. Reducing GHG emissions from new development alone cannot provide sufficient GHG reductions to achieve this long-term target. Therefore, climate action plans should address energy use and emissions from existing development as well. In its review of climate action plans, the APCD recommends aggressive and innovative strategies to achieve emission reductions from existing as well as new development.

6) Implementation and monitoring should be clearly defined

The parameters for determining if the CAP is being fully implemented, and if development projects are consistent with the CAP, must be clearly laid out. If a local government plans to tier future projects off the environmental review performed on a CAP, the monitoring program should include the following elements:

- *Annual tracking/reporting on implementation of all CAP measures, including measures that address existing development.* The phasing-in of mitigation measures should be addressed (i.e. — have all the measures that were to have been adopted or expanded in the past year actually been adopted/expanded?).
- *Annual reporting of how new development projects have been implementing CAP measures.* Tracking individual project attributes and implementation of mitigation measures should be done on a project-by-project basis. This can be facilitated through the use of a compliance checklist for new development projects to demonstrate consistency with the plan (listing all mandatory and voluntary measures that apply to new development) and whether the project is implementing the measures; the District will request a copy of this checklist (or similar documentation) when reviewing projects for CEQA.
- *Annual review of the State's implementation of measures included in the CAP.* Are state-level policies achieving the reductions anticipated?
- *Periodic update of the GHG inventory*. The APCD recommends updating the community-wide GHG inventory at least once every 5 years. However, updating the inventory on a more

frequent basis may improve the ability to monitor progress toward achieving the GHG reduction target in the CAP.

- *Analysis of whether the CAP is still a "qualified" plan for CEQA purposes.* The analysis should be based on level of implementation and effectiveness of measures.

4.7 Employees per 1000 sf, Based on Land Use

Table 4-3: Employees Based on Land Use

LAND USE	Employees per 1000sf
Automobile Care Center	2.47
Bank (w/drive-through)	1.59
City Park	0.23
Convenience Market w/gas pumps	2.50
Day-Care Center	1.01
Elementary School	0.55
Fast Food Restaurant w/drive-thru	6.22
Fast Food Restaurant w/o drive-thru	1.74
Gasoline/Service Station	2.22
General Light Industry	1.54
General Office Building	2.52
Golf Course	2.96
Government Office Building	3.63
Hardware/Paint Store	1.56
Health Club	2.47
High Turnover (Sit Down Restaurant)	1.97
Hospital	1.07
Hotel	0.64
Library	0.39
Medical Office Building	3.33
Motel	0.95
Place of Worship	0.80
Quality Restaurant	1.19
Refrigerated Warehouse-No Rail	0.66
Regional Shopping Center	1.39
Strip Mall	2.39
Unrefrigerated Warehouse-No Rail	0.84
Employees Per 1000sf developed from the historical trend analysis based on historical permit data from SLOCOG for the years 2001 to 2010	

MISSION BAY LAND USE PLAN

SAN FRANCISCO, CALIFORNIA | November 2005

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OEHHA
Office of Environmental Health Hazard Assessment

Air Toxicology and Epidemiology

ADOPTION OF AIR TOXICS HOT SPOTS PROGRAM GUIDANCE MANUAL FOR PREPARATION OF HEALTH RISK ASSESSMENTS [03/06/15]

In accordance with Health and Safety Code, Section 44300 et seq. (The Air Toxics Hot Spots Information and Assessment Act, AB 2588, Connelly as amended by SB 1731, Calderon), the Director of the Office of Environmental Health Hazard Assessment (OEHHA) hereby adopts The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.

OEHHA is releasing the final version of the document, Air Toxics Hot Spots Program Guidance Manual for the Preparation of Risk Assessments (Guidance Manual), February 2015, by posting on our Web site. This Guidance Manual has been developed by OEHHA, in conjunction with the Air Resources Board (ARB), for use in implementing the Air Toxics Hot Spots Program (Health and Safety Code Section 44360). OEHHA is required to develop guidelines for conducting health risk assessments under the Air Toxics Hot Spots Program (Health and Safety Code Section 44360 (b) (2)). OEHHA earlier developed three Technical Support Documents (TSDs) in response to this statutory requirement, which provided the scientific basis for values used in assessing risk from exposure to facility emissions. The three TSDs describe non-cancer risk assessment (derivation of acute, 8-hour and chronic reference exposure levels), derivation of cancer potency factors, and and exposure assessment methodology including stochastic risk assessment. These TSDs underwent public and peer review, were approved by the State's Scientific Review Panel on Toxic Air Contaminants, and adopted by OEHHA for use in the Air Toxics Hot Spots program. The Guidance Manual combines the critical information from the three TSDs into a manual for the preparation of health risk assessments.

A computer program, the Hot Spots Analysis and Reporting Program (HARP) has been developed by ARB as a tool to implement the risk assessments as outlined in this guidance manual. The HARP program is available from ARB http://www.arb.ca.gov/toxics/harp/harp.htm

2015 Hot Spots Guidance Manual

- Download the guidance document (excluding appendices) (6.4Mb)
- Download the entire appendices (18Mb)
- Download appendices A-F (2.3Mb)
  - Appendix A: Air Toxics Hot Spots Program List of Substances
  - Appendix B: Regulations and Legislation
  - Appendix C: Asbestos Conversion Factors & Cancer Potency Factor
  - Appendix D: Risk Assessment Procedures to Evaluate Particulate Emissions from Diesel-Fueled Engines
  - Appendix E: Toxicity Equivalency Factors for Polychlorinated Dibenzo-p-Dioxins, Dibenzofurans and Polychlorinated Biphenyls
  - Appendix F: Overview of the Lead Risk Assessment Procedures
- Download appendices G- J (1.8Mb)
  - Appendix G: PAH Potency Factors and Selection of Potency Equivalency Factors (PEF) for PAHs based on Benzo(a)pyrene Potency

- Appendix H: Recommendations for Estimating Concentrations of Longer Averaging Periods from the Maximum One-Hour Concentration for Screening Purposes
- Appendix I: Calculation Examples for Estimating Potential Health Impacts
- Appendix J: Glossary ofAcronyms and Definition ofSelectedTerms

- Download appendix K: (1.7Mb) HRA Forms and Maps Used With Air Dispersion Modeling

- Download appendices L-M (2.5Mb)
  - Appendix L: OEHHA/ARB Approved Health Values for Use in Hot Spot Facility Risk Assessments
  - Appendix M: How to Post-Process Offsite Worker Concentrations using the Hourly Raw Results from AERMOD

- Download Appendix N: (2.3Mb)Sensitivity Study of the Worker Adjustment Factor using AERMOD

Technical Support Documents

- Download the Air Toxics Hot Spots Program Technical Support Document for the Derivation of Noncancer Reference Exposure Levels, 2008
- Download the Air Toxics Hot Spots Program Technical Support Document for Cancer Potency Factors, 2009
- Download the Air Toxics Hot Spots Program Technical Support Document for Exposure Assessment and Stochastic Analysis, 2012

OEHHA
Office of Environmental Health Hazard Assessment

Air Toxicology and Epidemiology

ADOPTION OF THE REVISED AIR TOXICS HOT SPOTS PROGRAM TECHNICAL SUPPORT DOCUMENT FOR CANCER POTENCY FACTORS [06/01/09] APPENDIX C UPDATED 2011

The Office of Environmental Health Hazard Assessment (OEHHA) is required to develop guidelines for conducting health risk assessments under the Air Toxics Hot Spots Program (Health and Safety Code Section 44360(b)(2)). OEHHA initially developed Technical Support Documents (TSDs) in 1999-2000 in response to this statutory requirement, including one which listed and described the derivation of cancer potencies for individual air contaminants. OEHHA has developed a revised draft TSD, "Air Toxics Hot Spots Program Technical Support Document for Cancer Potencies," which is designed to replace the original TSDs. The revised TSD presents updated methodology that reflects scientific knowledge and techniques developed since the previous guidelines were prepared, and in particular to explicitly include consideration of possible differential effects on the health of infants, children and other sensitive subpopulations, in accordance with the mandate of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Chapter 731, Statutes of 1999, Health and Safety Code Sections 39669.5 et seq.).

A draft of the TSD was released on June 20, 2008 to solicit public comment. The document was then reviewed by the State's Scientific Review Panel on Toxic Air Contaminants (SRP). It was initially presented to the SRP on October 10, 2008. Revised versions of the document reflecting new data and comments from the public and the SRP were discussed at meetings held on December 5, 2008 and May 12, 2009. At the latter meeting, the SRP approved the final versions of the methodology section and the associated appendices.

Following this process, and by this memo, OEHHA is finalizing and adopting the TSD for Cancer Potency Factors. Adoption of the TSD does not automatically affect the existing cancer potency factors for individual air contaminants (which are listed in the appendices to the TSD). These existing cancer potency values are listed in Appendix A to the new TSD, and the toxicological summaries describing their derivation are presented in Appendix B. Any further new or revised cancer potencies approved by the SRP will be adopted and also included in these appendices.

Follow this link to download the "Air Toxics Hot Spots Risk Assessment Guidelines Part II: Technical Support Document for Cancer Potency Factors" (May 2009)

Appendices

Appendix A. A lookup table containing unit risk and cancer potency values. updated 2011

Appendix B. Chemical-specific summaries of the information used to derive unit risk and cancer potency values. updated 2011

Appendix C. A description of the use of toxicity equivalency factors for determining unit risk and cancer potency factors for polychlorinated dibenzo-p-dioxins, dibenzofurans and dioxin-like polychlorinated biphenyls. Revised 01/20/11

Appendix D. A listing of Toxic Air Contaminants identified by the California Air Resources Board.

Appendix E. Descriptions of the International Agency for Research on Cancer (IARC) and U.S. Environmental Protection Agency (U.S. EPA) carcinogen classifications.

Appendix F. An asbestos quantity conversion factor for calculating asbestos concentrations expressed as 100 fibers/m3 from asbestos concentrations expressed as μg/m3.

Appendix G. Procedures for revisiting or delisting cancer potency factors by the program of origin.

Appendix H. Exposure routes and studies used to derive cancer unit risks and slope factors.

Appendix I. “Assessing susceptibility from early-life exposure to carcinogens”: Barton et al., 2005 (from Environmental Health Perspectives).

Appendix J. “In Utero and Early Life Susceptibility to Carcinogens: The Derivation of Age-at-Exposure Sensitivity Measures” – conducted by OEHHA’s Reproductive and Cancer Hazard Assessment Branch.

Office of Environmental Health Hazard Assessment
OEHHA
State of California

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Office of Environmental Health Hazard Assessment

Air Toxicology and Epidemiology

NOTICE OF ADOPTION OF AIR TOXICS HOT SPOTS PROGRAM RISK ASSESSMENT GUIDELINES: REVISED TECHNICAL SUPPORT DOCUMENT FOR EXPOSURE ASSESSMENT AND STOCHASTIC ANALYSIS
[08/27/12]

The Office of Environmental Health Hazard Assessment (OEHHA) is adopting an updated version of the document, *Air Toxics Hot Spots Program Risk Assessment Guidelines: Technical Support Document for Exposure Assessment and Stochastic Analysis.* The document becomes available on the OEHHA Home Page at http://www.oehha.ca.gov on August 27, 2012.

BACKGROUND

OEHHA is required to develop guidelines for conducting health risk assessments under the Air Toxics Hot Spots Program (Health and Safety Code Section 44360(b)(2)). OEHHA previously developed Technical Support Documents (TSDs) in response to this statutory requirement, including one in 2000 for exposure assessment. This revised draft TSD replaces the original TSD, and reflects new scientific knowledge developed since the previous guidelines were prepared. We have updated exposure parameters (e.g., inhalation rate, food consumption rate, etc.) based on the most recent data, including exposure factors for infants and children, in accordance with the mandate of the Children's Environmental Health Protection Act (Senate Bill 25, Escutia, Chapter 731, Statutes of 1999, Health and Safety Code Sections 39669.5 *et seq.*). The revised document also updates the approach to assessing dermal exposure.

A draft version of this TSD was released for public comment on November 7, 2011, and was discussed at public workshops in Oakland and Diamond Bar, CA in December 2011. The document was then revised to reflect public comments, and peer reviewed by the State's Scientific Review Panel on Toxic Air Contaminants (SRP). It was initially presented to the SRP on April 5, 2012. A revised version of the document reflecting comments of the SRP was discussed at a second meeting held on June 25, 2012. At the latter meeting, the SRP approved the document describing the RELs and their derivation, subject to some additional editorial changes which have been incorporated into the final version.

Download the document Air Toxics Hot Spots Program Risk Assessment Guidelines: Technical Support Document for Exposure Assessment and Stochastic Analysis (**13.5 mb** file)

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3 Daily Breathing Rates

3.1 Introduction

This chapter presents age-specific breathing rates for use in health risk assessments for short-term exposure to maximum 1-hour facility emissions and for long-term daily average exposures resulting from continuous or repeated 8-hour exposure. The specified age ranges of interest in the “Hot Spots” program are ages third trimester, 0<2, 2<9, 2<16, 16<30 and 16-70 years.

The term ventilation rate has been frequently used for the metric of volume of air inhaled per minute (i.e., mL/min) and is used in this document to describe short-term, one hour exposures. For convenience, the term “breathing rate” is applied throughout this chapter for chronic daily exposure, both to the metric of volume of air inhaled per day (L/day) and the volume of air inhaled per kg body weight per day (L/kg-day). The normalized daily breathing rate in L/kg-day is the preferred metric for use in the “Hot Spots” program. The term “respiratory rate” is not used in this chapter interchangeably with “breathing rate” because respiratory rate usually represents the number of breaths taken per unit time, and not the volume of air taken in per unit time.

The 8-hour breathing rates were developed for specialized exposure scenarios that involve exposures only during facility operations of about 8-12 hours/day. Eight-hour breathing rates reflect exposures to off-site workers or exposures that may occur in schools when class is in session. Ventilation rates for 1-hour exposure were developed to meet the SB-352 mandate for school districts to conduct a risk assessment at school sites located within 100 meters of a freeway or busy roadway. These ventilation rates were developed for exposures to 1-hour maximum facility emissions that may occur during passive activities such as sitting at a desk during class instruction or during higher intensity activities such as play during recess.

OEHHA recommends the breathing rates presented in Section 3.2. Various published methods for deriving daily breathing rates and their advantages and limitations are discussed in Sections 3.3 to 3.7. Where possible, the breathing rates from these reports were re-evaluated to correspond with the five specific age groups used in OEHHA’s risk assessment guidelines.

At elevations above 5000 feet, the ventilation rate will increase due to lower air pressure (NOLS, 2012). The respiratory rate at this elevation peaks at one week and then slowly decreases over the next few months, although it tends to remain higher than its normal rate at sea level. There have been a few facilities located at 5000 feet or higher that have been required to produce a Hot Spots risk assessment. However, long-term residents at high altitude will have breathing rates near what is found in residents at sea level. OEHHA does not anticipate any adjustments will be needed to the breathing rates at higher altitudes in California, although the Districts should consider this issue and adjust if needed for very high altitude facilities.

3.2 Breathing Rate Recommendations

3.2.1 Long-Term Breathing Rates

The recommended long-term daily breathing rate point estimates in Table 3.1 are based on a mean of two different methods used to determine daily breathing rates, the doubly labeled water method and an energy intake approach based on food consumption data from the Continuing Survey of Food Intake of Individuals (CSFII) (See Section 3.5.5). These methods are described in detail below. The recommended distributions for stochastic analysis are presented in Tables 3.2a-b. The breathing rates normalized to body weight are expressed in L/kg-day, and the non-body weight-normalized breathing rates are expressed in m^3/day. All values were rounded to two or three significant figures.

Table 3.1. Recommended Point Estimates for Long-Term Daily Breathing Rates

	3rd Trimester	**0<2 years**	**2<9 years**	**2<16 years**	**16<30 years**	**16<70 years**
	L/kg-day					
Mean	225	658	535	452	210	185
95th Percentile	361	1090	861	745	335	290
	m^3/day					
Mean	15.3	6.2	10.7	13.3	15.0	13.9
95th Percentile	23.4	11.2	16.4	22.6	23.5	22.9

OEHHA calculated mean and high end breathing rates for the third trimester assuming the dose to the fetus during the third trimester was the same as that to the mother.

TABLE 3.2a. Recommended Breathing Rate Distributions (L/kg-day) by Age Group for Stochastic Analysis

	3rd Trimester	**0<2 years**	**2<9 years**	**2<16 years**	**16<30 years**	**16-70 years**
Distribution	Max extreme	Max extreme	Max extreme	Log-normal	Logistic	Logistic
Minimum	78	196	156	57	40	13
Maximum	491	2,584	1,713	1,692	635	860
Scale	59.31	568.09	125.59		40.92	36.19
Likeliest	191.50	152.12	462.61			
Location				-144.06		
Mean	225	658	535	452	210	185
Std Dev	72	217	168	172	75	67
Skewness	0.83	2.01	1.64	1.11	0.83	1.32
Kurtosis	3.68	10.61	7.88	6.02	5.17	10.83
Percentiles						
5%	127	416	328	216	96	86
10%	142	454	367	259	118	104
25%	179	525	427	331	161	141
50%	212	618	504	432	207	181
75%	260	723	602	545	252	222
80%	273	758	631	572	261	233
90%	333	934	732	659	307	262
95%	361	1090	861	745	335	290
99%	412	1430	1,140	996	432	361

TABLE 3.2b. Recommended Breathing Rate Distributions (M^3/day) by Age Group for Stochastic Analysis

	3rd Trimester	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
Distribution	Logistic	Log-normal	Log-normal	Log-normal	Logistic	Log-normal
Minimum	4.0	0.8	2.7	2.7	1.5	1.8
Maximum	29.0	20.1	31.7	52.3	75.4	75.4
Scale	2,403.72				2,992.97	
Location		-650.7	-1,072.8	598.9		-8,251.3
Mean	15.1	6.2	10.7	13.3	15.0	13.9
Std Dev	4.3	2.6	3.1	4.9	5.4	5.4
Skewness	0.48	1.06	0.912	1.39	1.16	1.42
Kurtosis	3.73	4.69	5.18	7.14	12.22	11.19
Percentiles						
5%	8.6	2.9	6.1	6.9	6.4	6.3
10%	10.4	3.3	6.9	8.1	8.5	7.6
25%	12.3	4.4	8.5	9.9	11.8	10.3
50%	15.1	5.8	10.4	12.3	14.7	13.6
75%	17.6	7.6	12.4	15.9	18.0	16.8
80%	18.2	8.1	13.0	16.7	18.9	17.6
90%	21.4	9.6	14.8	19.5	21.5	20.1
95%	23.4	11.2	16.4	22.6	23.5	22.9
99%	28.8	13.9	20.0	28.1	29.9	28.0

3.2.2 Eight-hour Breathing Rate Point Estimates

The 8-hour breathing rates are based on minute ventilation rates derived by U.S. EPA (2009). The minute ventilation rates, presented in Section 3.6, were multiplied by 480 (60 min x 8) to generate 8-hour breathing rate point estimates shown in Table 3.3. The 8-hour breathing rates may be useful for cancer risk assessment for the off-site worker exposure scenario, and school exposures to facility emissions. They may also be useful for evaluating residential exposures where the facility operates non-continuously. The 8-hour breathing rates vary depending on the intensity of the activity. Exposed individuals may be engaged in activities ranging from watching TV to desk work, which would reflect breathing rates of sedentary/passive or light activities, to yard work or farm worker activities, which would reflect breathing rates of moderate intensity or greater. Breathing rates resulting from high intensity activities generally cannot be sustained for an 8-hour period (see Section 3.6).

OEHHA recommends using point estimate 8-hour breathing rates in L/kg-8-hrs based on the mean and 95th percentile of moderate intensity activities, 170 and 230 L/kg-8-hrs, respectively, for adults 16-70 yrs old. Point estimates for lower breathing rates of sedentary/passive and light intensity work activities may be used in site-specific scenarios (i.e., work in which activity is limited to desk jobs or similar work). Pregnant women will generally participate in lower intensity activities than non-pregnant women, but as shown in Tables 3.1 and 3.2, breathing rate normalized to body weight will be slightly greater than breathing rates of adult men and non-pregnant women combined. OEHHA recommends using the mean and 95th percentile 8-hour breathing rates based on moderate intensity activity of 16<30 year-olds for third trimester women.

Table 3.3a. Eight Hour Breathing Rate (L/kg-8 Hr) Point Estimates for Males and Females Combined

	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	200	100	80	30	30
95th Percentile	250	140	120	40	40
	Light Intensity Activities (1.5 < METs ≤ 3.0)				
Mean	490	250	200	80	80
95th Percentile	600	340	270	100	100
	Moderate Intensity Activities (3.0 < METs ≤ 6.0)				
Mean	890	470	380	170	170
95th Percentile	1200	640	520	240	230

Table 3.3b. Eight-Hour Breathing Rate (M^3/8-Hr) Point Estimates for Males and females Combined

	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	1.86	2.24	2.37	2.33	2.53
95th Percentile	2.69	2.99	3.20	3.23	3.34
	Light Intensity Activities (1.5 < METs ≤ 3.0)				
Mean	4.61	5.44	5.66	5.72	6.03
95th Percentile	6.51	7.10	7.52	7.75	7.80
	Moderate Intensity Activities (3.0 < METs ≤ 6.0)				
Mean	8.50	10.20	10.84	12.52	12.94
95th Percentile	12.36	13.47	14.52	18.08	18.07

3.2.3 Short-term (1-Hour) Ventilation Rate Point Estimates

One-hour ventilation rates (Tables 3.4a-b) were calculated from U.S. EPA (2009) minute ventilation rates (e.g., minute ventilation rate x 60) to meet the SB-352 mandate for school districts to conduct a risk assessment for school sites located within 100 M of a freeway or busy roadway. These ventilation rates allow assessment of exposures to facility emissions during the course of the school day.

The age groups for children mostly deviate from those child age groupings designed for AB2588. The age groups attempt to address specific school categories (e.g., kindergarten, grade school, high school) under SB-352. However, if 1-hr ventilation rates are required that fit the AB2588 age groups, 1-hr ventilation rates can be calculated from the 8-hr breathing rates shown in Tables 3.28a-b.

Table 3.4a. One-Hour Breathing Rates for SB352 School Sites in L/kg-60 min (Males and Females Combined)

	0<2 Years	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	25	17	10	6	4
95th Percentile	31	23	14	8	5
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	61	41	23	14	10
95th Percentile	75	54	32	19	13
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	110	76	44	28	21
95th Percentile	140	100	62	39	29
	High Intensity Activities (METS ≥ 6.0)				
Mean	-	140	82	55	38
95th Percentile	-	190	110	80	56

Table 3.4b. One-Hour Breathing Rates for SB352 School Sites in M^3/60 min (Males and Females Combined)

	0<2 Years	**2<6 years**	**6<11 years**	**11<16 years**	**16-70 years**
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	0.23	0.27	0.29	0.33	0.32
95th Percentile	0.34	0.36	0.39	0.45	0.42
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	0.58	0.68	0.68	0.76	0.75
95th Percentile	0.81	0.86	0.91	1.03	0.97
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	1.06	1.25	1.30	1.50	1.62
95th Percentile	1.54	1.63	1.73	2.05	2.26
	High Intensity Activities (METS ≥ 6.0)				
Mean	-	2.24	2.49	2.92	3.01
95th Percentile	-	2.98	3.51	4.18	4.39

For children at school, MET activity levels equivalent to sitting at a desk during instruction and outside at play can be used as guidance for determining 1-hour breathing rates. As shown in Table 3.26 below, sitting was assigned a MET of 1.5, while play outdoors, recess and physical education had mean MET values in the range of 4.5 to 5.0 (U.S. EPA, 2009). Thus, 1-hour breathing rates based on sedentary/passive or light activities to represent activities within the class room and moderate intensity activities to represent activities during recess and some physical education classes, are recommended.

U. S. EPA (2009) also determined ventilation rates for high intensity activities with MET values $\geq$ 6.0. The distributions generated by U.S. EPA for hrs/day spent at MET values ≥6.0 for infants (age 0<2 yrs) suggests that this level of activity is unlikely for this age group. However, there is a subgroup of children in the older child age groups that exercise at this level for at least one hr/day, although this level of activity may not happen all in one hour's time. OEHHA recommends using 1-hr high intensity ventilatory rates for after-school sports and training that require high energy output such as track, football, tennis etc. This MET category may also be used for demanding sports during physical education classes.

3.3 Estimation of Daily Breathing Rates

3.3.1 Inhalation Dose and Cancer Risk

The approach to estimating cancer risk from long-term inhalation exposure to carcinogens requires calculating a range of potential doses and multiplying by cancer potency factors in units of inverse dose to obtain a range of cancer risks. This range reflects variability in exposure rather than in the dose-response. In equation 3-1, the daily breathing rate (L/kg BW-day) is the variate which is varied for each age group.

The general algorithm for estimating dose via the inhalation route is as follows:

$$DOSEair = Cair \times [BR/BW] \times A \times EF \times (1 \times 10^{-6}) \quad \textbf{(Eq. 3-1)}$$

where:

DOSEair	= dose by inhalation (mg/kg BW-day)
Cair	= concentration in air (µg/m^3)
[BR/BW]	= daily breathing rate normalized to body weight (L/kg BW-day)
A	= inhalation absorption factor, if applicable (default = 1)
EF	= exposure frequency (days/365 days)
1×10^{-6}	= conversion factors (µg to mg, L to m^3)

The inhalation absorption factor (A) is a unitless factor that is only used if the cancer potency factor itself includes a correction for absorption across the lung. It is inappropriate to adjust a dose for absorption if the cancer potency factor is based on applied rather than absorbed dose. The exposure frequency (EF) is set at 350 days per year (i.e., per 365 days) to allow for a two week period away from home each year.(US EPA, (1991). Another factor may come into consideration in the inhalation dose equation, the fraction of time at home (FAH). See Chapter 11 for more details.
For cancer risk, the risk is calculated for each age group using the appropriate age sensitivity factors (ASFs) and the chemical-specific cancer potency factor (CPF), expressed in units of (mg/kg-day)$^{-1}$.

$$RISKair = DOSEair * CPF * ASF * ED/AT \qquad \textbf{(Eq. 3-2)}$$

RISK is the predicted risk of cancer (unitless) over a lifetime as a result of the exposure, and is usually expressed as chances per million persons exposed (e.g., 5 x 10^{-6} would be 5 chances per million persons exposed).

The dose-response phase of a cancer risk assessment aims to characterize the relationship between an applied dose of a carcinogen and the risk of tumor appearance in a human. This is usually expressed as a cancer potency factor, or CPF, in the above equation. The CPF is the slope of the extrapolated dose-response curve and is expressed as units of inverse dose $(mg/kg\text{-}d)^{-1}$, or inverse concentration $(\mu g/m^3)^{-1}$.

Exposure duration (ED) is the number of years within the age groupings. In order to accommodate the use of the ASFs (OEHHA, 2009), the exposure for each age grouping must be separately calculated. Thus, the DOSEair and ED are different for each age grouping. The ASF, as shown below, is 10 for the third trimester and infants 0<2 years of age, is 3 for children age 2<16 years of age, and is 1 for adults 16 to 70 years of age.

ED = exposure duration (yrs):

0.25 yrs for third trimester	(ASF = 10)
2 yrs for 0<2 age group	(ASF = 10)
7 yrs for 2<9 age group	(ASF = 3)
14 yrs for 2<16 age group	(ASF = 3)
14 yrs for 16<30 age group	(ASF = 1)
54 yrs for 16-70 age group	(ASF = 1)

AT, the averaging time for lifetime cancer risks, is 70 years in all cases. To determine lifetime cancer risks, the risks are then summed across the age groups:

$$RISKair_{(lifetime)} = RISKair_{(3rdtri)} + RISKair_{(0<2\ yr)} + RISKair_{(2<16\ yr)} + RISKair_{(16\text{-}70yr)} \qquad \textbf{(Eq. 3-3)}$$

As explained in Chapter 1, we also need to accommodate cancer risk estimates for the average (9 years) and high-end (30 years) length of time at a single residence, as well as the traditional 70 year lifetime cancer risk estimate. For example, assessing risk in a 9 year residential scenario assumes exposure during the most sensitive period, from the third trimester to 9 years of age and would be presented as follows:

$$RISKair_{(9\text{-}yr\ residency)} = RISKair_{(3rdtri)} + RISKair_{(0<2\ yr)} + RISKair_{(2<9\ yr)} \qquad \textbf{(Eq. 3-4)}$$

For 30-year residential exposure scenario, the 2<16 and 16<30 age group RISKair would be added to the risk from exposures in the third trimester and ages 0<2yrs. For 70 year residency risk, Eq 3-3 would apply.

3.3.2 Methods for Estimating Daily Breathing Rates

Two basic techniques have been developed to indirectly estimate daily breathing rates: the time-activity-ventilation (TAV) approach and an energy expenditure derivation method. Ideally, daily breathing rates would be directly measured. However, the equipment for direct measurement is bulky and obtrusive and thus impractical for measuring breathing rates over an entire 24-hour period, especially on children performing their typical activities. Thus, ventilation measurements are typically taken for shorter time periods under specific conditions (e.g., running or walking on a treadmill).

The TAV approach relies on estimates or measurements of ventilation rates at varying physical activity levels, and estimates of time spent each day at those activity levels. An average daily breathing rate is generated by summing the products of ventilation rate (L/min) and time spent (min/day) at each activity level.

The second approach derives breathing rates based on daily energy expenditure and was first proposed by Layton (1993). Layton reasoned that breathing rate is primarily controlled by the amount of oxygen needed to metabolically convert food into energy the body can use. Because the volume of oxygen required to produce one kcal of energy and the ratio of the volume of oxygen consumed to the volume of air inhaled per unit time are both constant values, the amount of energy a person expends is directly proportional to the volume of air the person breathes. Layton (1993) developed an equation that models this relationship and that can be used to derive breathing rates from energy expenditure data:

$$VE = H \times VQ \times EE \qquad \textbf{(Eq. 3-5)}$$

where:

VE = the volume of air breathed per day (L/day),
H = the volume of oxygen consumed to produce 1 kcal of energy (L/kcal),
VQ = the ratio of the volume of air to the volume of oxygen breathed per unit time and is referred to as the breathing equivalent (unitless)
EE = energy (kcal) expended per day

Layton calculated an H value of 0.21 L/kcal for noninfant children. Arcus-Arth and Blaisdell (2007) calculated essentially the same H value of 0.22 L/kcal from data of non -breastfed infants based on food surveys. For VQ, Layton calculated a value of 27 from adult data. Children have different respiratory minute ventilation rates, as well as other respiratory parameter values, relative to adults. Therefore, children’s VQ values can be different from those of adults. Arcus-Arth and Blaisdell (2007) calculated VQ values for children from which daily breathing rates can be derived (Table 3.5).

Table 3.5. Mean VQ Values Calculated for Children

	Weighted mean VQ	Recommended VQ
Infants 0-11 mo.	nd[a]	33.5
Boys & girls 1-3 yrs	nd[a]	33.5
Boys & girls 4-8 yrs	33.5	33.5
Boys 9-18 yrs	30.6	30.6
Girls 9-18 yrs	31.5	31.5

[a] Insufficient or no data

Three variations of estimating EE have been used based on conversion of metabolic energy to derive a breathing rate: (1) from the caloric content of daily food intake, (2) as the product of basal metabolic rate (BMR) and ratios of average daily energy expenditure to BMR, and (3) as time-weighted averages of energy expenditure (expressed as multiples of BMR) across different levels of physical activity during the course of a day. Published reports applying these variations in metabolic energy conversion to arrive at breathing rates using Layton's equation are summarized below.

In addition to using energy intake data with Layton's method to derive breathing rates, an approach called the doubly labeled water (DLW) technique has also been used to derive total energy expenditure and is summarized below. The DLW data have been shown to be quite accurate, but the approach has only been applied to specific sub-populations.

3.4 Available Daily Breathing Rate Estimates

There are a number of sources of information on daily breathing rates for various age groups and other subpopulations that have been derived via the methods described above. Some sources have compiled breathing rates from other studies.

3.4.1 Traditional Breathing Rate Estimation

The book Reference Man (Snyder et al., 1975), a report by the International Commission on Radiological Protection (ICRP), presents breathing rates based on about 10 limited studies. Using an assumption of 8 hour (hr) resting activity and 16 hr light activity and the breathing rates (see Table 3.6), ICRP recommended daily breathing rates of 23 m^3/day for adult males, 21 m^3/day for adult females, and 15 m^3/day for a 10 year old child. In addition, assuming 10 hr resting and 14 hr light activity each day, ICRP recommends a daily breathing rate of 3.8 m^3/day for a 1 year old. Finally, assuming 23 hr resting and 1 hr light activity, ICRP recommends a daily breathing rate of 0.8 m^3/day for a newborn. The breathing rates estimated by the ICRP used sources that had a small sample size and were limited in scope. Table 3.6 is the minute volume data upon which the daily breathing rates were based.

Table 3.6. Minute Volumes from ICRP'S Reference Man [a]

	Resting L/min (m^3/hr)	Light Activity L/min (m^3/hr)
Adult male	7.5 (0.45)	20 (1.2)
Adult female	6.0 (0.36)	19 (1.14)
Child, 10 yr	4.8 (0.29)	13 (0.78)
Child, 1 yr	1.5 (0.09)	4.2 (0.25)
Newborn	0.5 (0.03)	1.5 (0.09)

[a] Data compiled from available studies measuring minute volume at various activities by age/sex categories

This report provided the approach used in traditional risk assessment, in that a single estimate of daily breathing was employed, often 20 m^3/day for a 70-kg person.

3.4.2 Daily Breathing Rate Estimates Based on Time-Activity-Ventilation (TAV) Data

3.4.2.1 Marty et al. (2002)

Marty et al. (2002) derived California-specific distributions of daily breathing rates using estimates and measurements of ventilation rates at varying physical activity levels, and estimates of time spent each day at those activity levels. Two activity pattern studies were conducted in which activities of a randomly sampled population of 1762 adults and 1200 children were recorded retrospectively for the previous 24 hours via telephone interview (Phillips et al., 1991; Wiley et al., 1991a; Wiley et al., 1991b; Jenkins et al., 1992). Measured breathing rates in people performing various laboratory and field protocols were conducted by Adams et al. (1993). The subjects in this study were 160 healthy individuals of both sexes, ranging in age from 6 to 77 years. An additional forty 6 to 12 year olds and twelve 3 to 5 year olds were recruited for specific protocols.

For adults, each activity was assigned to a resting, light, moderate, moderately heavy, or heavy activity category to reflect the ventilation rate that could reasonably be associated with that activity. For children there were only resting, light, moderate, and heavy activity categories. The ventilation rates were classified into similar levels (e.g., the lying down protocol was considered the resting category of ventilation rate). The measured ventilation for each individual in the lab and field protocols was divided by that person's body weight. For each individual, the time spent at each activity level was summed over the day. The mean ventilation rate for each category (resting, etc.) was then multiplied by the summed number of minutes per day in that category to derive the daily breathing rate for each category. The breathing rates were then summed over categories to give a total daily breathing rate. The moments and percentiles for the raw derived breathing rates as well as for the breathing rates fit to a gamma distribution are presented in Tables 3.7 and 3.8 for the combined group of adolescents and adults (i.e., >12 years age) and for children (<12 years age). OEHHA staff also derived distributions of breathing rates for the equivalent of a 63-kg adult and an 18-kg child. These breathing rates form the basis of the current risk assessment guidelines (OEHHA, 2000), which this document is revising.

Table 3.7 Children's (<12 Years) Daily Breathing Rates (L/Kg-Day)

	Moments and Percentiles from Empirical Data	Moments and Percentiles, Fitted Gamma Parametric Model	Breathing Rate Equivalent for a 18 kg Child, m^3/Day (Empirical Data)
N	1200		
Mean	452	451	8.1
Std Dev	67.7	66.1	1.22
Skewness	0.957	0.9	
Kurtosis	1.19	4.32	
%TILES	**L/kg-day**		
1%	342.5	(not calculated)	6.17
5%	364.5	360.3	6.56
10%	375	374.9	6.75
25%	401.5	402.7	7.23
50%	441	440.7	7.94
75%	489.5	488.4	8.81
90%	540.5	537.9	9.73
95%	580.5	572.1	10.5
99%	663.3	(not calculated)	11.9
Sample Max	747.5		13.5

Table 3.8 Adult/Adolescent (>12 Years) Breathing Rates (L/kg-Day)

	Moments and Percentiles from Empirical Data	Moments and Percentiles, Fitted Gamma Parametric Model	Breathing Rate Equivalent for a 63 kg Adult, m^3/Day
N	1579		
Mean	232	233	14.6
Std Dev	64.6	56.0	4.07
Skewness	2.07	1.63	
Kurtosis	6.41	6.89	
%TILES	**L/kg-day**		
1%	174	(Not calculated)	11.0
5%	179	172.3	11.3
10%	181	178.0	11.4
25%	187	192.4	11.8
50%	209	218.9	13.2
75%	254	257.9	16.0
90%	307	307.8	19.3
95%	381	342.8	24.0
99%	494.0	(Not calculated)	31.1
Sample Max	693		43.7

Advantages of these rates are that the activity pattern data were from a large randomly sampled population of California adults and children, and that ventilation rates were normalized by body weight for each individual in the ventilation rate study. However, body weight information was not available for the activity pattern subjects. Measured breathing rates during specified activities were also collected from California participants with the intention that the data would be used in conjunction with the activity pattern data to derive daily breathing rates.

Limitations include the use of one-day activity pattern survey data that may tend to overestimate long-term daily breathing rates because both intraindividual variability and interindividual variability are poorly characterized. However, intraindividual variability is believed to be small relative to interindividual variability, which would make the breathing rate distributions reasonably accurate for chronic exposure assessment. Despite these limitations, the derived breathing rates were reasonably similar to those measured by the doubly-labeled water method (described in (OEHHA, 2000)).

Because the time-weighted average method involves professional judgment in assigning a breathing rate measured during a specific activity to various other types of activities, some uncertainty is introduced into the resulting daily breathing rates. Lastly, there is a paucity of breathing rate data for specific activities in children in the 3 to 6 year age range, and no data for children and infants younger than 3 years old. Thus, only a broad age range (i.e., < 12 years old) could be used for estimating daily breathing rates in children. Daily breathing rates cannot be reliably estimated from this study for children and infants over narrow age ranges, such as the critical 0<2 year age group.

3.4.2.2 Allan et al. (2008)

Allan et al. (2008) also estimated breathing rates for specified age groups by the TAV approach, but employed a greater number of time-activity data sets than that used by Marty et al. (2002). This study updated TAV inhalation rate distributions from a previous report by Allan and Richardson (1998) by incorporating supplemental minute volume and time-activity data, and by correlating minute volume with metabolic equivalents (METs) for performing the physical activities at the time of measurement. Published time-activity and minute volume data used by Marty et al. (2002) were also used by the authors to develop the distributions (Wiley et al., 1991a; Wiley et al., 1991b; Adams, 1993), but also a number of other reports primarily conducted in the USA and Canada.

Their TAV approach calculated mean expected breathing rates for five different activity levels (i.e., level 1 – resting; level 2 – very light activity; level 3 – light activity; level 4 – light to moderate activity, level 5 – moderate to heavy activity). For infants, only three levels of activity were defined (i.e., sleeping or napping, awake but not crying, and crying).

Probability density functions describing 24-hour inhalation rates were generated using Monte Carlo simulation and can be described with lognormal distributions. Table 3.9 presents the estimated breathing rates in m^3/day for males and females (combined) by age groupings commonly used in Canada for risk assessment purposes. In their report, Allan et al. (2008) also provided breathing rates for males and females separately. However, breathing rate distributions adjusted for body weight (m^3/day-kg) were not included in the report.

Table 3.9. Allan et al. (2008) TAV-Derived Daily Breathing Rates (m^3/Day) for Males And Females Combined

Age Category	Males and Females Combined (m^3/day)			
	Mean + SD	**50%-ile[a]**	**90%-ile[a]**	**95%-ile[a]**
Infants (0-6 mo)	2.18 ± 0.59	2.06	2.87	3.12
Toddlers (7 mo-4 yr)	8.31 ± 2.19	7.88	10.82	11.72
Children (5-11 yr)	14.52 ± 3.38	13.95	18.49	19.83
Teenagers (12-19 yr)	15.57 ± 4.00	14.80	20.09	21.69
Adults (20-59 yr)	16.57 ± 4.05	15.88	21.30	22.92
Seniors (60+ yr)	15.02 ± 3.94	14.35	19.72	21.36

[a] Percentiles provided courtesy of Allan (e-mail communication)

Allan et al. (2008) compared the breathing rate distribution derived by the DLW method (see below, Table 3.12) to their TAV breathing rate probability density function results and found that there appeared to be longer tails in the upper bounds for all age groups except teenagers and infants for the TAV method, suggesting the TAV distribution gives a better representation of the more exposed members of the population such as athletes. For teenagers, the TAV and DLW distributions show considerable overlap. But for infants, lower breathing rates were observed by the TAV approach compared with the DLW approach. The authors could not explain this discrepancy. Unlike the Marty et al. (2002) study, daily breathing rates could be estimated in infants and toddlers. However, there is still a shortage of TAV data in children in the younger age groups relative to adults.

Uncertainty was reduced by grouping activities by expected METs. However, Allen et al. (2008) noted that there is still uncertainty about actual physical exertion at an activity level because of the way some source studies grouped activities (e.g., grouping walking with running). Uncertainty was also reduced by using, wherever possible, studies that documented all activities over a multi-day period rather than studies that considered only a few hours of behavior. Nevertheless, there is some uncertainty in combining data from disparate studies and in assigning ventilation rates to activities that are not described by energy expenditure levels. In particular, interpolations and extrapolations were used to fill in minute volume data gaps and may have resulted in overestimates or underestimates. For example, minute volume data for some activity levels in toddlers and children were considered insufficient to adequately characterize their minute volumes.

3.4.3 Daily Breathing Rate Estimates Based on Energy Expenditure

As discussed above, Layton (1993) developed a mathematical equation to estimate daily breathing rates based on energy expenditure. The paper also presented examples of breathing rates that had been derived using this method.

3.4.3.1 Layton (1993)

Layton took three approaches to estimating breathing rates from energy estimates. The first approach used the U.S.D.A.'s National Food Consumption Survey (1977-78) data to estimate energy (caloric) intake. The National Food Consumption Survey used a retrospective questionnaire to record three days of food consumption by individuals in households across the nation, and across all four seasons. Layton recognized that food intake is underreported for individuals 9 years of age and older in these surveys and therefore adjusted the reported caloric intake for these ages. These data are no longer the most current population based energy intake data available. Further, the breathing rates are not normalized to body weight.

The second approach to estimating breathing rates multiplied the BMR estimated for a given age-gender group by the estimated ratio of energy intake to basal metabolic rate (EFD/BMR) for that age-gender group. The BMR can be determined as a linear function of body weight, after accounting for gender and age. An activity multiplier can then be applied which is derived from previously reported ratios of daily food intake to BMR. The advantages of this approach include linking breathing rates to BMR, which is valuable since breathing rates are considered to be determined primarily by BMR.

However, the BMR for each age-gender group was calculated from equations derived from empirical but non-representative data. Further, these data were collected using techniques that may be outdated (e.g., for the 0-3 year age group, 9 of the 11 studies were conducted between 1914 and 1952). These data may no longer be representative of the current population. The EFD/BMR ratios for males and females over 18 years of age were estimated from data collected over one year in one study while those for other age groups were estimated based on the consistency of the value in calculating energy expenditures similar to other studies. Average body weights do not capture the variability of body weights in the population. Thus the BMR values may not be as accurate as current technology can provide nor are they representative of the population.

Layton's third approach to calculate daily breathing rates involves the metabolic equivalent (MET) approach, which is a multiple of the BMR and reflects the proportional increase in BMR for a specific activity. For example, the MET for standing is 1.5 (i.e., 1.5*BMR), and the MET for cycling and swimming is 5.3. Layton categorized METs into 5 levels (from light activity with a MET = 1 to very strenuous activities with a MET = 10). MET levels were then assigned to each activity in a study that had categorized activities by energy expenditure level and recorded the time study participants spent at each activity. The energy expended at each activity was converted to a breathing rate and then summed over the day to give a daily breathing rate. However, the time-activity data used in this approach were only available for ages over 18 years.

The results of Layton's approaches are presented in Table 3.10. Layton did not report statistical distributions of the breathing rates that he derived. Other limitations, for our purposes, are that the breathing rates in Table 3.6 are not representative of the current U.S. population, are not normalized to body weight, and were for broad age ranges. In addition, no distributions were reported in the paper.

Table 3.10. Layton (1993) Estimates of Breathing Rate Based on Caloric and Energy Expenditure

Method	Breathing Rate – Men m^3/day	Breathing Rate – Women m^3/day
Time-weighted average lifetime breathing rates based on food intake	14	10
Average daily breathing rates based on the ratio of daily energy intake to BMR	13-17 (over 10 years of age)	9.9-12 (over 10 years of age)
Breathing rates based on average energy expenditure	18	13

Finley et al. (1994) presented probability distributions for several exposure factors, including inhalation rates. Based on the data Layton used to derive point estimates via his third approach (i.e., with energy expenditure equivalent to a multiple of BMR), Finley et al. (1994) expanded on Layton's results to develop a probability distribution for breathing rate for several age groups (Table 3.11).

Table 3.11. Selected Distribution Percentiles from Finley et al. (1994) for Breathing Rates by Age

Age Category (years)	Percentile (m^3/day)		
	50th	90th	95th
<3	4.7	6.2	6.7
3 -10	8.4	10.9	11.8
10 – 18	13.1	17.7	19.3
18 – 30	14.8	19.5	21.0
30 – 60	11.8	15.4	16.7
>60	11.9	15.6	16.7

Because Finley largely used the same data as Layton to develop breathing rate distributions, the same limitations apply.

3.4.3.2 Arcus-Arth and Blaisdell (2007)

Arcus-Arth and Blaisdell (2007) derived daily breathing rates for narrow age ranges of children and characterized statistical distributions for these rates. The rates were derived using the metabolic conversion method of Layton (1993) and energy intake data (calories consumed per day) from the Continuing Survey of Food Intake of Individuals (CSFII) 1994–1996, 1998 conducted by the USDA (2000). The CSFII provided the most recent population based energy data at the time. The CSFII dataset consisted of two days of recorded food intake for each individual along with self-reported body weights. The individual data allowed for the assessment of interindividual variability. Because one-day intakes may be less typical of average daily intake, the two-day intakes were averaged to obtain a better estimate of typical intake available from these limited repeated measures. The CSFII energy intakes were weighted to represent the U.S. population. The rates were intended to be more representative of the current U.S. children's population than prior rates that had been derived using older or non-representative data.

The premise for Layton's equation is that breathing rate is proportional to the oxygen required for energy expenditure. While there are no energy expenditure data that are representative of the population, there are population representative energy intake data (i.e., calories consumed per day). Energy intake data can be used in Layton's equation when energy intake equals energy expenditure. Energy intake is equal to energy expended when the individual is neither gaining nor losing body weight (i.e., all energy intake is expended). Because the percentage of daily energy intake that is needed to result in a discernible change in body weight for adults is very small, it can be assumed that for adults energy intake equals energy expended. However, in young infants, a significant portion of their daily energy intake is deposited in new tissue (e.g., adipose, bone and muscle). The deposited energy is referred to as the energy cost of deposition (ECD). Therefore, the daily energy intake needed for normal growth of infants is used both for energy expenditure (EE) and ECD (i.e., energy intake = EE + ECD). If the breathing rate is to be estimated by the caloric intake approach for growing infants, the ECD must be subtracted from the total daily energy intake in order to determine an accurate breathing rate.

Accounting for the ECD is primarily important for newborn infants (Butte et al., 1990; Butte et al., 2000). For example, at ages 3 and 6 months the energy cost for growth constituted 22 and 6%, respectively, of total energy requirements. In older children the energy cost is only 2-3% of total energy requirements. By the age of 25 years in males and 19 years in females, the ECD has essentially decreased to zero and remains at that level throughout adulthood (Brochu et al., 2006a).

Because Layton's equation requires only energy expenditure to derive the breathing rate, a small modification to Eq. 3-5 is made when deriving the infant breathing rate using the caloric intake approach:

$$VE = H \times VQ \times (TDEI - ECD) \times 10^{-3} \qquad \text{(Eq. 3-6)}$$

where:

TDEI = Total daily energy intake (kcal/day)
ECD = Daily energy cost of deposition (kcal/day)

Arcus-Arth and Blaisdell (2007) subtracted the ECD from the TDEI to give a more accurate estimate of energy expended. The ECD for each month of age for infants up to 11 months of age was estimated from Scrimshaw et al. (1996). Although there is typically a burst of growth just prior to and during adolescence, Arcus-Arth and Blaisdell did not subtract the ECD during adolescence because investigators considered it negligible relative to total energy intake (Spady, 1981; Butte et al., 1989).

Layton (1993) reported on the bias associated with underreporting of dietary intakes by older children. He calculated a correction factor for this bias (1.2) and multiplied the daily energy intake of each child nine years of age and older by 1.2. Arcus-Arth and Blaisdell, having evaluated the literature and finding Layton's adjustment to be reasonable, likewise multiplied daily energy intake of adolescent ages by 1.2.

Arcus-Arth and Blaisdell (2007) also evaluated the numerical values used by Layton for the VQ and H conversion factors in his metabolic equation. Their estimated value for the conversion factor H was similar to that found by Layton. However, they found data in the literature indicating that other values of VQ may be more specific to children than those used by Layton (see Table 3.5). The VQ values Arcus-Arth and Blaisdell calculated were used to derive breathing rates.

Non-normalized (L/day) and normalized (L/kg-day) breathing rates shown in Tables 3.8a-e) were derived for both children and adults from the CSFII dataset using the methodology described in Arcus-Arth and Blaisdell (2007). Briefly, the CSFII used a multistage complex sampling design to select individuals to be surveyed from the population. The CSFII recommended using a Jacknife Replication (JK) statistical method (Gossett et al., 2002; Arcus-Arth and Blaisdell, 2007), which is a nonparametric technique that is preferred to analyze data from multistage complex surveys.

For each age group, the mean, standard error of the mean, percentiles (50th, 90th, and 95th) of non-normalized and normalized breathing rates, derived as described, are presented in Tables 3.12a and 3.12b, respectively. Child breathing rates are for males and females combined, except for the 9-18 yr adolescent age group breathing rates shown at the bottom of the tables.

TABLE 3.12a. Non-Normalized Daily Breathing Rates (L/Day) for Children and Adults Using CSFII Energy Intake and Layton's Equation

Age	Sample Size Nonweighted	Mean	SEM	50%-ile	90%-ile	95%-ile	SE of 95%-ile
Age (months)	**Infancy**						
0-2	182	3630	137	3299	5444 [1]	7104 [1]	643
3-5	294	4920	135	4561	6859	7720	481
6-8	261	6089	149	5666	8383	9760	856
9-11	283	7407	203	6959	10,212	11,772	**
0-11	1020	5703	98	5323	8740	9954	553
Age (years)	**Children**						
1	934	8770	75	8297	12,192	13,788	252
2	989	9758	100	9381	13,563	14,807	348
3	1644	10,642	97	10,277	14,586	16,032	269
4	1673	11,400	90	11,046	15,525	17,569	234
5	790	12,070	133	11,557	15,723	18,257	468
6	525	12,254	183	11,953	16,342	17,973	868
7	270	12,858	206	12,514	16,957	19,057	1269
8	253	13,045	251	12,423	17,462	19,019	1075
9	271	14,925	286	14,451	19,680	22,449 [1]	1345
10	234	15,373	354	15,186	20,873	22,898 [1]	1021
11	233	15,487	319	15,074	21,035	23,914 [1]	1615
12	170	17,586	541	17,112	25,070 [1]	29,166 [1]	1613
13	194	15,873	436	14,915	22,811 [1]	26,234 [1]	1106
14	193	17,871	615	15,896	25,748 [1]	29,447 [1]	4382
15	185	18,551	553	17,913	28,110 [1]	29,928 [1]	1787
16	201	18,340	536	17,370	27,555	31,012	2065
17	159	17,984	957	15,904	31,421 [1]	36,690 [1]	**
18	135	18,591	778	17,339	28,800 [1]	35,243 [1]	4244
0<2	1954	7502	75	7193	11,502	12,860	170
2<16	7624	14,090	120	13,128	20,993	23,879	498
	Adolescent Boys						
9-18	983	19,267	278	17,959	28,776	32,821	1388
	Adolescent Girls						
9-18	992	14,268	223	13,985	21,166	23,298	607

[1] Value may be less statistically reliable than other estimates due to small cell size

** Unable to calculate

Table 3.12b. Normalized Daily Breathing Rates (L/kg-Day) for Children and Adults Using CSFII Energy Intake and Layton's Equation

Age	Sample Size Nonweighted	Mean	SEM	50%-ile	90%-ile	95%-ile	SE of 95%-ile
Age (months)	**Infancy**						
0-2	182	839	42	725	1305	1614	290
3-5	294	709	24	669	1031	1232	170
6-8	261	727	16	684	1017	1136	73
9-11	283	760	20	710	1137	1283	96
0-11	1020	751	11	694	1122	1304	36
Age (years)	3.4.3.3 **Children**						
1	934	752	7	716	1077	1210	33
2	989	698	9	670	986	1107	31
3	1644	680	6	648	966	1082	18
4	1673	645	5	614	904	1011	19
5	790	602	7	587	823	922	25
6	525	550	10	535	765	849	28
7	270	508	9	495	682	788	39
8	253	458	11	439	657	727	37
9	271	466	11	445	673	766 [1]	21
10	234	438	12	425	661	754 [1]	38
11	233	378	9	350	566	616 [1]	32
12	170	373	13	356	545 [1]	588 [1]	46
13	194	311	12	289	459 [1]	588 [1]	55
14	193	313	12	298	443 [1]	572 [1]	92
15	185	299	10	285	461 [1]	524 [1]	25
16	201	278	10	258	434	505	46
17	159	276	15	251	453 [1]	538 [1]	**
18	135	277	10	244	410 [1]	451 [1]	42
0<2	1954	752	6	706	1094	1241	24
2<16	7624	481	3	451	764	869	6
	Adolescent Boys						
9-18	983	367	5	343	567	647	14
	Adolescent Girls						
9-18	992	315	6	288	507	580	24

[1] Value may be less statistically reliable than other estimates due to small cell size

** Unable to calculate

Ideally, breathing rates and other variates used in risk assessment should be as representative as possible of the exposed population. Population representative daily energy (caloric) intake can be estimated from national food consumption surveys, such as the CSFII and the National Health and Nutrition Examination Survey (NHANES). These surveys can be analyzed to provide results that are representative of the nation and of several subpopulations, including narrow age groups. The sample sizes are large with these surveys and thus provide relatively robust results, which is of particular concern for the tails of probability distributions.

Limitations for the CSFII energy intake-derived breathing rates include the underreporting of food intakes discussed above. Underestimation of energy intake leads to underestimation of breathing rates. Another limitation is that only two days of food intake data had been collected. Although collection of two consecutive days of food intake is an improvement over earlier collections of one day of food intake, the repeated measures in the survey were still too limited to reduce the impact of daily variations in food intake and would tend to overestimate the upper and lower percentiles. Typical intake is not captured by the caloric intake of two days, and breathing rate and dietary intake on any given day are not tightly coupled.

3.4.3.4 US EPA (2009) Metabolic Equivalent-Derived Daily Breathing Rate Estimates

Similar to one of the approaches Layton (1993) used to estimate the breathing rate, U.S. EPA employed a metabolic equivalent (METS) approach for estimating breathing rates. This method determines daily time-weighted averages of energy expenditure (expressed as multipliers of the basal metabolic rate) across different levels of physical activity. METs provide a scale for comparing the physical intensities of different activities. Recent energy expenditure data including the 1999-2002 NHANES and U.S EPA's Consolidated Human Activity Database (CHAD) were used that considers variability due to age, gender, and activities. NHANES (CDC, 2000; 2002) was used as the source of body weight data, and CHAD (U.S. EPA, 2002) was the central source of information on activity patterns and METS values for individuals. The 4-year sampling weights assigned to the individuals within NHANES 1999-2002 were used to weight each individual's data values in the calculations of these statistics.

Data were grouped into age categories and a simulated 24-hour activity pattern was generated by randomly sampling activity patterns from the set of participants with the same gender and age. Each activity was assigned a METS value based on statistical sampling of the distribution assigned by CHAD to each activity code. Using statistical software, equations for METS based on normal, lognormal, exponential, triangular and uniform distributions were generated as needed for the various activity codes. The METS values were then translated into energy expenditure (EE) by multiplying the METS by the basal metabolic rate (BMR), which was calculated as a linear function of body weight. The VO2 was calculated by multiplying EE by H, the volume of oxygen consumed per unit energy.

The inhalation rate for each activity within the 24-hour simulated activity pattern for each individual was then estimated as a function of VO2, body weight, age, and gender. Following this, the average inhalation rate was calculated for each individual for the entire 24-hour period, as well as for four separate classes of activities based on METS value (sedentary/passive [METS less than or equal to 1.5], light intensity [METS greater than 1.5 and less than or equal to 3.0], moderate intensity [METS greater than 3.0 and less than or equal to 6.0], and high intensity [METS greater than 6.0]. Data for individuals were then used to generate summary tables with distributional data based on gender and age categories (Tables 3.13a and 3.13b). No parametric distributional assumptions were placed on the observed data distributions before these statistics were calculated.

Table 3.13a. US EPA (2009) Metabolically-Derived Daily Breathing Rate (m^3/Day in Males and Females Unadjusted For Body Weight

Age Category (years)	Means and Percentiles in m^3/day							
	Males				Females			
	Mean	50th	90th	95th	Mean	50th	90th	95th
Birth to <1	8.76	8.70	11.93	12.69	8.53	8.41	11.65	12.66
1	13.49	13.11	17.03	17.89	13.31	13.03	17.45	18.62
2	13.23	13.19	16.27	17.71	12.74	12.60	15.58	16.37
3 to <6	12.65	12.58	14.63	15.41	12.16	12.02	14.03	14.93
6 to <11	13.42	13.09	16.56	17.72	12.41	11.95	15.13	16.34
11 to <16	15.32	14.79	19.54	21.21	13.44	13.08	16.25	17.41
16 to <21	17.22	16.63	21.94	23.38	13.59	13.20	17.12	18.29
21 to <31	18.82	18.18	24.57	27.14	14.57	14.10	19.32	21.14
31 to <41	20.29	19.83	26.77	28.90	14.98	14.68	18.51	20.45
41 to <51	20.93	20.60	26.71	28.37	16.20	15.88	19.91	21.35
51 to <61	20.91	20.41	27.01	29.09	16.18	15.90	19.93	21.22
61 to <71	17.94	17.60	21.78	23.50	12.99	12.92	15.40	16.15

Table 3.13b. US EPA (2009) Metabolically-Derived Daily Breathing Rate (m^3/Kg-Day) in Males and Females Adjusted for Body Weight

Age Category (years)	Means and Percentiles in m^3/kg-day							
	Males				Females			
	Mean	50th	90th	95th	Mean	50th	90th	95th
Birth to <1	1.09	1.09	1.26	1.29	1.14	1.13	1.33	1.38
1	1.19	1.17	1.37	1.48	1.20	1.18	1.41	1.46
2	0.95	0.94	1.09	1.13	0.95	0.96	1.07	1.11
3 to <6	0.70	0.69	0.87	0.92	0.69	0.68	0.88	0.92
6 to <11	0.44	0.43	0.55	0.58	0.43	0.43	0.55	0.58
11 to <16	0.28	0.28	0.36	0.38	0.25	0.24	0.31	0.34
16 to <21	0.23	0.23	0.28	0.30	0.21	0.21	0.27	0.28
21 to <31	0.23	0.22	0.30	0.32	0.21	0.20	0.26	0.28
31 to <41	0.24	0.23	0.31	0.34	0.21	0.20	0.27	0.30
41 to <51	0.24	0.23	0.32	0.34	0.22	0.21	0.28	0.31
51 to <61	0.24	0.24	0.30	0.34	0.22	0.21	0.28	0.30
61 to <71	0.21	0.20	0.24	0.25	0.18	0.17	0.21	0.22

US EPA (2009) described the strengths and weaknesses of their approach. The strengths of this metabolically-derived method include nationally representative data sets with a large sample size, even within the age and gender categories. This approach also yields an estimate of ventilation rate that is a function of VO2 rather than an indirect measure of oxygen consumption such as VQ as other researchers have used.

Another strength is that the breathing rates included a BMR component which had been derived from NHANES body weights and to which NHANES sampling weights were linked. The BMR component of the breathing rates was representative of the population because of the sampling weights. That is, the degree of association between body weight and breathing rate was incorporated into the distribution of breathing rate distributions.

However, the degree of association between breathing rate and other characteristics (e.g., race, geographic region) was not incorporated into the distributions (US EPA, 2009). These non-body weight characteristics can be highly associated with variability in activity patterns. Although BMR may contribute the greatest percent to the quantitative breathing rate value, the variability in breathing rates is most likely driven by differing levels of physical activity by different persons. Because the activity data was collected over a 24-hour period, day-to-day variability is not well characterized (US EPA, 2009; US EPA, 2011). The outcome is that the simulated 24-hour activity pattern assigned to an NHANES participant is likely to contain a greater variety of different types of activities than one person may typically experience in a day.

Furthermore, because the simulated activity profiles did not consider possible limits on the “maximum possible METS value” that would account for previous activities, ventilation rates may be overestimated (US EPA, 2009). This happens, in part, because the MET approach does not take into consideration correlations that may exist between body weight and activity patterns. For example, high physical activity levels can be associated with individuals of high body weight, leading to unrealistically high inhalation rates at the upper percentiles levels (US EPA 2011). The result is that the central tendency of the MET breathing rates may be fairly representative of the population, but the breathing rates may not appropriately capture the variability within the population. This limitation was probably most evident in children <3 years of age where the data used to calculate BMR values may be less representative of the current population (US EPA, 2009).

3.4.4 Daily Breathing Rate Estimates from Doubly Labeled Water Measurements

In another method used to quantify human energy expenditure, published doubly-labeled water (DLW) energy expenditure data can be used in conjunction with Layton’s equation to convert metabolic energy to daily inhalation rates (Brochu et al., 2006a; 2006b; Stifelman, 2007). In the DLW method, isotopically labeled water containing $^{2}H_{2}0$ (i.e., heavy water) and $H_{2}{}^{18}0$ is given orally to the study participant. The isotopes then distribute in the body and disappear from body water pools by dilution from new unlabeled water into the body, by the excretion of the labeled isotope from the body, or by the production of CO_2. The difference in disappearance rates between the two isotopes represents CO_2 production over an optimal period of 1–3 half-lives (7 to 21 days in most human subjects) of the labeled water. CO_2 production is an indirect measure of metabolic rate and can be converted into units of energy using knowledge of the chemical composition of the foods consumed.

A major advantage of the DLW method is that it provides an index of total energy expenditure over a period of 1 to 3 weeks, which is a more biologically meaningful period of time compared to the other methods, and can reduce the impact of daily variations in physical activity or food intake (IOM, 2005). In addition, the DLW method is non-invasive, requiring only that the subject drink the stable isotopes and provide at least three urine samples over the study period. Thus, measurements can be made in subjects leading their normal daily lives (i.e., free-living individuals). The DLW method is considered to be the most accurate method for determining the breathing rate of an individual (IOM, 2005).

A disadvantage is that the DLW method is expensive to undertake, and that essentially all the available studies investigated different age ranges but the subjects were not randomly selected to be representative of populations. However, measurements are available in a substantial number of men, women and children whose ages, body weights, heights and physical activities varied over wide ranges.

DLW measurements of total daily energy expenditures (TDEE) include basal metabolism, physical activity level, thermogenesis, and the synthetic cost of growth (Butte et al., 2000). The synthetic cost of growth is the energy that is expended to synthesize the molecules that will be stored. This is different from the energy deposited for growth (ECD), which is the energy intake that is deposited in the body for new tissue. The ECD is an important factor in newborn infants and is not accounted for in DLW measurements. Thus, the derivation of breathing rates using Layton's equation does not require an adjustment to subtract out the ECD to determine TDEE, as was necessary for deriving the breathing rates of infants by the caloric intake approach (Section 3.5.3.2).

3.4.4.1 Brochu et al. (2006a,b)

Brochu et al. (2006a) calculated daily inhalation rates for 2210 individuals aged 3 weeks to 96 years using DLW energy expenditure data mainly from the IOM (2005). The IOM database is a compilation of DLW-derived energy expenditure results and other raw data from individuals collected from numerous studies. Breathing rates were estimated for different groups of individuals including healthy normal-weight males and females with normal active lifestyles (n=1252), overweight/obese individuals with normal active lifestyles (n=679), individuals from less affluent societies (n=59), underweight adults (n=34), and individuals during various extreme physical activities (n=170). Normal weight adults age 20 yrs and above were categorized as having BMIs between 18.5 and 25 kg/m^2. Overweight/obese adults had BMIs above 25 kg/m^2. For children and teenagers aged 4 to 19 yrs, BMIs corresponding to the 85th percentile or below were considered normal. The breathing rate data were presented as 5th, 10th, 25th, 50th, 75th, 90th, 95th, and 99th percentile values as well as mean and SEM values for the derived inhalation rates for narrow age groups ranging from 1 month to 96 years. A partial listing of the breathing rate percentiles for normal weight individuals by age group are shown in Tables 3.14a and 3.14b.

Table 3.14a. Means and Percentiles of Daily Breathing Rates (in m^3/Day) for Free-Living Normal-Weight Males and Females Derived from DLW Measurements by Brochu et al. (2006a)

Age Category (years)	Means and Percentiles in m^3/day									
	Males[a]					Females[a]				
	N	Mean	50th	90th	95th	N	Mean	50th	90th	95th
0.22 to <0.5	32	3.38	3.38	4.30	4.57	53	3.26	3.26	4.11	4.36
0.5 to <1	40	4.22	4.22	5.23	5.51	63	3.96	3.96	4.88	5.14
1 to <2	35	5.12	5.12	6.25	6.56	66	4.78	4.78	6.01	6.36
2 to <5	25	7.60	7.60	9.25	9.71	36	7.06	7.06	8.54	8.97
5 to <7	96	8.64	8.64	10.21	10.66	102	8.22	8.22	9.90	10.38
7 to <11	38	10.59	10.59	13.14	13.87	161	9.84	9.84	12.00	12.61
11 to <23	30	17.23	17.23	21.93	23.26	87	13.28	13.28	16.61	17.56
23 to <30	34	17.48	17.48	21.08	22.11	68	13.67	13.67	16.59	17.42
30 to <40	41	16.88	16.88	20.09	21.00	59	13.68	13.68	15.94	16.58
40 to <65	33	16.24	16.24	19.67	20.64	58	12.31	12.31	14.96	15.71
65 to <96	50	12.96	12.96	16.13	17.03	45	9.80	9.80	12.58	13.37

[a] Percentiles based on a normal distribution assumption for all age groups

Table 3.14b. Means and Percentiles of Daily Breathing Rates (in m^3/kg-Day) for Free-Living Normal-Weight Males and Females Derived from DLW Measurements by Brochu et al. (2006a)

Age Category (years)	Mean and Percentiles in m^3/kg-day									
	Males[a]					Females[a]				
	N	Mean	50th	90th	95th	N	Mean	50th	90th	95th
0.22 to <0.5	32	0.509	0.509	0.627	0.661	53	0.504	0.504	0.623	0.657
0.5 to <1	40	0.479	0.479	0.570	0.595	63	0.463	0.463	0.545	0.568
1 to <2	35	0.480	0.480	0.556	0.578	66	0.451	0.451	0.549	0.577
2 to <5	25	0.444	0.444	0.497	0.512	36	0.441	0.441	0.532	0.559
5 to <7	96	0.415	0.415	0.475	0.492	102	0.395	0.395	0.457	0.474
7 to <11	38	0.372	0.372	0.451	0.474	161	0.352	0.352	0.431	0.453
11 to <23	30	0.300	0.300	0.360	0.377	87	0.269	0.269	0.331	0.349
23 to <30	34	0.247	0.247	0.297	0.311	68	0.233	0.233	0.287	0.302
30 to <40	41	0.237	0.237	0.281	0.293	59	0.235	0.235	0.279	0.292
40 to <65	33	0.230	0.230	0.284	0.299	58	0.211	0.211	0.257	0.270
65 to <96	50	0.188	0.188	0.228	0.239	45	0.172	0.172	0.220	0.233

[a] Percentiles based on a normal distribution assumption for all age groups

Comparing the largest subgroups (i.e., overweight/obese individuals vs. normal-weight individuals), Brochu et al. observed that overweight/obese individuals inhaled between 0.8 to 3.0 m^3 more air per day than normal-weight individuals, but their physiological daily breathing rates are 6 to 21% lower than that of their leaner counterparts when expressed in m^3/kg-day. Also of interest is that the daily inhalation rates (in m^3/kg-day) of newborns and normal-weight infants aged 2.6 to less than 6 months are 2.1 to 5.1 times higher than those of normal-weight and overweight/obese adults aged 18 to 96 years with normal lifestyles.

Besides the lack of randomly selected individuals representative of a population for estimating energy expenditure, much of the DLW data used to derive the breathing rate percentiles relied heavily on adults with sedentary lifestyles (Black et al., 1996). Occupations of many participants included professionals, white collar workers or other sedentary occupations, and almost no participants were in manual labor occupations that are known to result in higher breathing rates. Although a small group of athletic individuals appear to be included in the DLW database by Brochu et al. (2006a), it was suggested by Black et al. (1996) that not enough participants involved in manual labor are represented in the DLW database. This may result in breathing rate percentiles that are lower than what might be obtained from a population-based study. Nevertheless, as noted above, the DLW method provides an index of total energy expenditure over a period of 1 to 3 weeks, which is a better determinant of long-term breathing rate than other methods described that rely on 1 to 2 days of energy intake or expenditure to estimate long-term breathing rates. Thus, the DLW method is considered to be the most accurate method for determining an average daily breathing rate of a free-living individual.

3.4.4.2 Stifelman (2007)

Using energy expenditure data based on extensive DLW measurements from two sources (FAO, 2004a; 2004b; IOM, 2005), Stifelman (2007) calculated inhalation rates with Layton's equation for long-term physical activity levels categorized as active to very active individuals. The breathing rate data are presented in Table 3.15 in one year age groupings for infants and children and in three age groupings for adults up to age 70.

TABLE 3.15. Equivalent Breathing Rates Based on Institute of Medicine Energy Expenditure Recommendations for Active and Very Active People

Age (Years)	Inhalation rate – males active – very active (m^3/day)	Inhalation rate – females active – very active (m^3/day)
<1	3.4	3.4
1	4.9	4.9
2	5.9	5.5
3	8.4 – 9.5	7.9 – 9.3
4	8.8 – 10.1	8.3 – 9.9
5	9.4 – 10.7	8.8 – 10.5
6	9.8 – 11.3	9.3 – 11.1
7	10.4 – 11.9	9.7 – 11.6
8	10.9 – 12.6	10.2 – 12.3
9	11.5 – 13.3	10.7 – 12.8
10	12.1 – 14.0	11.1 – 13.4
11	12.9 – 14.9	11.7 – 14.1
12	13.7 – 15.9	12.3 – 14.9
13	14.8 – 17.2	12.9 – 15.6
14	16.0 – 18.5	13.2 – 16.0
15	17.0 – 19.8	13.3 – 16.2
16	17.8 – 20.7	13.4 – 16.3
17	18.2 – 21.2	13.3 – 16.2
18	18.6 – 21.5	13.2 – 16.1
19-30	17.0 – 19.7	13.4 – 15.2
31-50	16.2 – 18.9	12.8 – 14.5
51-70	15.1 – 17.8	12.0 – 13.8

Physical activity levels (PALs) were categorized into four levels of activity by the IOM, two of which were the active and very active levels. A PAL is the ratio of total energy expended (TEE) divided by the basal metabolic rate, defined as the minimum level of energy needed to support essential physiologic functions in free-living people. Stifelman (2007) also calculated the breathing rate associated with each level, as shown in Table 3.16. It is believed unlikely that the PAL “very active” category (i.e., PAL range 1.9-2.5) would be exceeded over a duration of years. PALs exceeding the IOM and FAO ranges are generally not sustainable over long periods of time, but can be quite high for limited periods of time (Westerterp, 2001). For example, highly trained athletes during periods of high-intensity training competition, including cross-country skiers and Tour de France bicycle racers, can reach a PAL of 3.5-5.5.

The IOM and FAO PALs describe a range of 1.4-2.5 in accord with ranges of sustainable PALs described by others, including people actively engaged in non-mechanized agriculture, deployed military personnel, and long-distance runners (Stifleman, 2007; Westerterp, 2001; Westerterp, 1998; Black et a., 1996; Haggerty et al., 1994). Individuals among the general population exceeding PALs of 2-2.5 for long periods of time are expected to experience negative energy balance (i.e., weight loss) mainly because an important limit to sustainable metabolic rate is the energy intake (Westerterp 1998; Westerterp, 2001).

TABLE 3.16. IOM Physical Activity Categories, Associated Breathing Rates and Equivalent Walking Distance

PAL Category	PAL midpoint value (range)	Breathing rate midpoint value	Equivalent walking distance (km /day)[a]
Sedentary	1.25 (1.0-1.39)	14.4 m^3/day	0
Low active	1.5 (1.4-1.59)	15.7 m^3/day	3.5
Active	1.75 (1.6-1.89)	17.3 m^3/day	11.7
Very active	2.2 (1.9-2.5)	19.4 m^3/day	26.9

[a] Equivalent walking distance in addition to energy expended during normal daily life, based on a 70 kg adult walking 5-6 km per hour. Adapted from Stifelman (2007) and Brooks et al. (2004)

Based on the DLW data, Stifelman's analysis indicates that human energy expenditure occurs within a fairly narrow range of activity levels (PAL in the range of 1.4-2.5), and that for breathing rates estimated by the DLW method, a breathing rate of 19.4 m^3/day (equivalent to a PAL of 2.2) is near the maximum energy expenditure that can be sustained for long periods of time in adults. This finding supports the idea that the traditional 20 m^3/day is an upper end breathing rate (Snyder et al. (1975).

The narrow range in breathing rates was found to be consistent with the daily energy expenditure estimated from the adult breathing rate distribution in Marty et al. (2002) where the range is slightly over 2-fold between the 5th and 95th percentile in Table 3.7. A roughly 2-fold range in between the 5th and 95th percentiles is also exhibited in the MET-derived breathing rates by US EPA (2009).

3.4.4.3 Limits of Sustainable Breathing Rates Derived from PALs

As noted above, DLW studies have shown that a PAL of approximately 2 to 2.5 in the general population of adults is the limit of sustainable energy expenditure for long periods of time (Westerterp, 2001; IOM, 2005; Stifelman, 2007). The PAL of novice athletes training for endurance runs and soldiers during field training falls within this range (Westerterp, 1998; 2001). The PAL has been found to be twice the upper limit (PALs = 3.5 to 5.5) in professional endurance athletes in the most demanding sports (cross-country skiing and cycling) during training and competition. The PALs of these professional athletes are in the right tail of the breathing rate distribution of the general population (Westerterp, 2001). However, the high PALs are not expected to be sustained at these high levels when averaged over years.

Knowing the average basal energy expenditure (BEE) for adults and the upper range of daily energy expenditure, the upper limit of long-term daily breathing rates for the general population can be estimated from Layton's equation (eq. 3.1). Marty et al. (2002) observed that the 95th percentile breathing rate should be found within this PAL range of 2 to 2.5. Thus, it might be reasonable to compare the 95th percentile adult breathing rate calculated by other methods to the breathing rates derived from an upper limit PAL range of 2 to 2.5.

Table 3.17 show the expected breathing rates of adults in a PAL range of 2.0 to 2.5. The mean BEE in kcal/day for the adult age groups is obtained from Brooks et al. (2004). Mean weights for the adult age groups were also obtained from this reference in order to convert breathing rates in L/day to L/kg-day. The results from the DLW-derived energy expenditure data suggest that for normal weight adults (i.e., adults with BMIs within the healthy range of 18.5 to 25), the upper limit of breathing rates for males and females combined would be 16,629 to 20,787 L/day, or 256 to 320 L/kg-day.

Table 3.17. Description of the Normative Adult DLW Data from Brooks et al. (2004) for Persons with a Healthy BMI, and the Resulting Calculations of Breathing Rate Within the Sustainable PAL Range of 2.0 to 2.5

	Age years	n	Mean BEE kcal/d	TEE limits[a] kcal/d	Breathing rate L/d	Mean weight kg	Breathing rate L/kg-d
Males	19-30	48	1769	3538 - 4423	20,060 - 25,078	71.0	283 - 353
	31-50	59	1675	3350 - 4188	18,995 - 23,746	71.4	266 - 333
	51-70	24	1524	3048 - 3810	17,282 - 21,603	70.0	247 - 309
	19-70[b]	-	-	-	18,582 - 23,229	-	263 - 328
Females	19-30	82	1361	2722 - 3403	15,434 - 19,295	59.3	260 - 325
	31-50	61	1322	2644 - 3305	14,991 - 18,739	58.6	256 - 320
	51-70	71	1226	2452 - 3065	13,903 - 17,379	59.1	235 - 294
	19-70[b]	-	-	-	14,675 - 18,344	-	249 - 311
Males/ females[c]	19-70	-	-	-	16,629 - 20,787	-	256 - 320

[a] Sustainable PAL range (2.0 to 2.5) multiplied by mean BEE equals the daily total energy expenditure (TEE) that can be sustained over long periods of time.
[b] 19-70 yr breathing rates calculated as a weighted average from the three smaller age groupings
[c] Average breathing rates of males and females combined, assuming each gender represents 50% of the population.

Although the PAL limits were estimated for adults, it might also be useful to estimate high-end sustainable breathing rates for adolescents using the same assumption that a PAL of 2 to 2.5 represents the limit of sustainable energy expenditure over a long-term period. Some of the highest daily breathing rates in L/day were calculated for adolescents from the CSFII caloric intake data (Arcus-Arth and Blaisdell, 2007).

For deriving adolescent breathing rates from the mean BEE in Brooks et al. (2004) for 14-18 year olds, an upper limit of sustainable energy expenditure would be in the range of 3458-4323 kcal/d for males, and 2722-3403 kcal/d for females. Using Layton's equation to derive the breathing rates from these daily energy expenditures, sustainable upper limit breathing rates of 22,221-27,780 L/day for adolescent males, and 18,006-22,511 L/day for adolescent females were calculated. After normalizing for weight using the mean weights for the 14-18 year age groups in Brooks et al. (2004), upper range daily breathing rates of 378-472 L/kg-day for males and 332-513 L/kg-day for females were calculated.

3.4.5 Compilations of Breathing Rate Data

In the US EPA (2011) Exposure Factors Handbook, ranges of measured breathing rate values were compiled for infants, children and adults by age and sex. Table 3.18 presents the recommended breathing rate values for males and females combined for specific age groups up to age ≥81 yrs based on the average of the inhalation rate data from four recent key studies: Brochu et al. (2006a); U.S. EPA, (2009); Arcus-Arth and Blaisdell, (2007); and Stifelman (2007). The Table represents the unweighted means and 95th percentiles for each age group from the key studies. U.S. EPA noted that there is a high degree of uncertainty associated with the upper percentiles, including the 95th percentile shown in Table 3.18, thus they should be used with caution. The upper percentiles represent unusually high inhalation rates for long-term exposures, but were included in the handbook to provide exposure assessors a sense of the possible range of inhalation rates for children.

Table 3.18. US EPA (2011) Recommended Long-Term Exposure (More than 30 Days) Breathing Rate Values for Infants and Children (Males and Females Combined) Averaged From Four Key Studies

Age Group	Mean m^3/day	Sources Used for Means	95th Percentile m^3/day	Sources Used for 95th-ile
Birth to <1 month	3.6	a	7.1	a
1 to <3 months	3.5	a,b	5.8	a,b
3 to <6 months	4.1	a,b	6.1	a,b
6 to <12 months Birth to <1 year	5.4 5.4	a,b a,b,c,d	8.0 9.2	a,b a,b,c
1 to <2 years	8.0	a,b,c,d,	12.8	a,b,c
2 to <3 years	8.9	a,b,c,d	13.7	a,b,c
3 to <6 years	10.1	a,b,c,d	13.8	a,b,c
6 to <11 years	12.0	a,b,c,d	16.6	a,b,c
11 to <16 years	15.2	a,b,c,d	21.9	a,b,c
16 to <21 years	16.3	a,b,c,d	24.6	a,b,c
21 to <31 years	15.7	b,c,d	21.3	b,c
31 to <41 years	16.0	b,c,d	21.4	b,c
41 to <51 years	16.0	b,c,d	21.2	b,c
51 to <61 years	15.7	b,c,d	21.3	b,c
61 to <71 years	15.7	b,c,d	18.1	b,c
71 to <81 years	14.2	b,c	16.6	b,c
≥91 years	12.2	b,c	15.7	b,c

a Arcus-Arth and Blaisdell, 2007; b Brochu et al. 2006a;
c U.S. EPA, (2009) d Stifelman 2007

3.5 OEHHA-Derived Breathing Rate Distributions for the Required Age Groupings Using Existing Data.

The summarized published reports provide breathing rate distributions by month/year of age or in specific age groups, but seldom in age groups applicable to OEHHA's age groupings for cancer risk assessment. However, individual data were obtainable from the CSFII food intake study and the DLW database in the IOM (2005) report, from which breathing rate distributions could be derived in the specific age groups of third trimester, 0<2, 2<9, 2<16, 16<30, and 16-70 years. In addition, the U.S. EPA's breathing rate distributions based on the MET approach, shown in Tables 3.13a and 3.13b, can be merged to obtain the necessary age group breathing rates.

3.5.1 OEHHA-derived breathing rates based on CSFII energy intake data

In Tables 3.19a-e, non-normalized (L/day) and normalized (L/kg-day) breathing rates for the specific OEHHA age groups were derived for both children and adults from the CSFII dataset using the Jacknife Replication statistical method (Arcus-Arth and Blaisdell, 2007). Breathing rates for pregnant women, for determination of third trimester breathing rates, are presented in Section 3.5.4.

In addition, each age group was also fit to a lognormal distribution using Crystal Ball® (Oracle Corp., Redwood Shores, CA, 2009). Crystal Ball® was also used to determine the best parametric model fit for the distribution of breathing rates for each age group. The Anderson-Darling test was chosen over other goodness-of-fit tests available in Crystal Ball® because this test specifically gives greater weight to the tails than to the center of the distribution. OEHHA is interested in the tails since the right tail represents the high-end (e.g., 95^{th} percentile) breathing rates.

Tables 3.19a-e. Breathing Rate Distributions by Age Group (Males and Females Combined) Derived from CSFII Food Intake Data Using Jacknife Methodology and Parameter Estimates of Log-Normally and Best Fit Distributions

Table 3.19a. Breathing Rate Distributions for the 0<2 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Max Extreme	Lognormal
N (sample)	1954	1954	-	-	-	-
Skewness	na[a]	na	0.74	0.77	1.47	0.77
Kurtosis	na	na	3.96	4.34	7.81	4.34
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	43	79	-	-	-	-
Mean (SE)[b]	752 (9)	7502 (91)	752 (1)	7568 (13)	752 (1)	7568 (13)
50%-ile (SE)	706 (7)	7193 (91)	720	7282	706	7282
75%-ile (SE)	870 (11)	9128 (91)	909	9201	871	9201
90%-ile (SE)	1094 (19)	11,502 (120)	1107	11,523	1094	11,523
95%-ile (SE)	1241 (24)	12,860 (170)	1241	12,895	1241	12,895
Sample Max	2584	24,411	-	-	-	-

[a] Not applicable [b] SE = Standard error

Table 3.19b. Breathing Rate Distributions For the 2<9 Year Age Group

	Jacknife Approach		**Lognormal Parametric Model**		**Best Fit Parametric Model**	
					Log-normal	Lognormal
N (sample)	6144	6144	-	-	-	-
Skewness	na[a]	na	0.95	0.86	0.95	0.86
Kurtosis	na	na	4.63	4.96	4.63	4.96
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	144	2661	-	-	-	-
Mean (SE)[b]	595 (4)	11,684 (82)	595 (1)	11,680 (16)	595 (1)	11,680 (16)
50%-ile (SE)	567 (5)	11,303 (70)	567	11,303	567	11,303
75%-ile (SE)	702 (5)	13,611 (110)	702	13,606	702	13,606
90%-ile (SE)	857 (7)	16,010 (170)	857	16,012	857	16,012
95%-ile (SE)	975 (9)	17,760 (229)	975	17,758	975	17,758
Sample Max	1713	31,739	-	-	-	-

[a] Not applicable [b] SE = Standard error

Table 3.19c. Breathing Rate Distributions for the 2<16 Year Age Group

	Jacknife Approach		Lognormal Parametric Model		Best Fit Parametric Model	
					Gamma	Max Extreme
N (sample)	7624	7624	-	-	-	-
Skewness	na[a]	na	0.74	0.75	0.91	1.46
Kurtosis	na	na	3.97	4.02	4.38	7.26
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	57	2661	-	-	-	-
Mean (SE)[b]	481 (5)	14,090 (135)	481 (1)	14,094 (24)	481 (1)	14,095 (24)
50%-ile (SE)	450 (5)	13,128 (110)	456	13,465	451	13,131
75%-ile (SE)	603 (4)	16,644 (189)	606	17,239	603	16,655
90%-ile (SE)	764 (6)	20,993 (361)	763	21,214	763	20,993
95%-ile (SE)	869 (6)	23,879 (498)	868	23,870	868	23,886
Sample Max	1713	53,295	-	-	-	-

[a] Not applicable [b] SE = Standard error

Table 3.19d. Breathing Rate Distributions for the 16<30 Year Age Group

	Jacknife Approach		Lognormal Parametric Model		Best Fit Parametric Model	
					Max Extreme	Lognormal
N (sample)	2155	2155	-	-	-	-
Skewness	na[a]	na	0.69	1.90	1.69	1.90
Kurtosis	na	na	3.75	11.15	8.94	11.15
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	23	1029	-	-	-	-
Mean (SE)[b]	197 (3)	13,759 (204)	200 (<1)	13,899 (31)	200 (<1)	13,899 (31)
50%-ile (SE)	180 (3)	12,473 (125)	190	12,494	182	12,494
75%-ile (SE)	238 (4)	16,975 (245)	259	17,192	242	17,192
90%-ile (SE)	320 (4)	21,749 (305)	331	22,136	323	22,136
95%-ile (SE)	373 (11)	26,014 (634)	378	26,481	377	26,481
Sample Max	976	75,392	-	-	-	-

[a] Not applicable [b] SE = Standard error

Table 3.19e. Breathing Rate Distributions for the 16-70 Year Age Group

	Jacknife Approach		Lognormal Parametric Model		Best Fit Parametric Model	
					Max Extreme	Lognormal
N (sample)	8512	8512	-	-	-	-
Skewness	na[a]	na	0.67	2.05	1.87	2.05
Kurtosis	na	na	3.74	12.35	10.67	12.35
%-ile or mean	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
Sample Min	13	740	-	-	-	-
Mean (SE)[b]	165 (2)	12,078 (134)	165 (<1)	12,074 (26)	165 (<1)	12,074 (26)
50%-ile (SE)	152 (1)	10,951 (86)	157	10,951	152	10,951
75%-ile (SE)	200 (1)	14,687 (141)	212	14,685	200	14,685
90%-ile (SE)	257 (3)	18,838 (173)	269	18,834	257	18,834
95%-ile (SE)	307 (4)	21,812 (371)	307	21,831	307	21,831
Sample Max	975	75,392	-	-		

[a] Not applicable

[b] SE = Standard error

3.5.2 OEHHA-derived breathing rates based on the IOM DLW Database

The Institute of Medicine (IOM) 2005 dietary reference report includes an extensive database that is a compilation of DLW-derived energy expenditure results and other raw data for individuals collected from numerous studies. An advantage of this dataset over the U.S. EPA MET approach and the TAV approaches is that individual data on energy expenditure are matched with the weight and age of the individuals. The disadvantage is that the data are not necessarily representative of a random sample of a population.

When breathing rates were calculated from the energy expenditure data, it became apparent that there were some extreme individual breathing rates that did not appear physically possible. Using the results from the PAL limits (Section 3.4.4.3), breathing rates with a PAL greater than 2.5 were removed. Additionally, some breathing rates were below the expected BMR for an individual. Based on evidence that energy expenditure during sleep is 5 to 10% lower than the BMR, derived breathing rates that were 10% or more below the expected BMR were also removed (Brooks et al., 2004). However, relatively few individuals were removed due to an extreme breathing rate; <1 to 6% of the values were removed from any one age group.

Rather than assume a normal distribution for the age groupings as Brochu et al. (2006a) had done, OEHHA arranged the data to be more representative of a population by weighting the energy expenditure data by age and gender. The modeled populations were weighted towards an equal number of persons per year of age and the assumption was used that males and females in a population are at a ratio of 50:50. In addition, the IOM database separated individuals by weight, or more specifically, by body mass index

(BMI). Children 3 to 18 years of age are considered at risk of overweight when their BMI is greater than the 85th percentile, and overweight when their BMI is greater than the 95th percentile (Kuczmarski et al., 2000). Thus, the IOM (2005) placed overweight/obese children in a separate dataset. For the modeled populations, an 85:15 weighting for normal:overweight children in the 2<9 and 2<16 age groups was used. Adults (>19 years of age) were placed in the overweight/obese dataset if they had BMIs of 25 kg/m^2 and higher by the IOM. The results from USDA's 1994-96 Diet and Health Knowledge Survey (Tippett and Clevelend, 2001) found that 54.6% of the U.S. population have a BMI of 25 kg/m^2 or greater (n=5530). Thus, for the adult age groups (16<30 and 16-70 yrs), 45:55 weighting for normal:overweight adults was used to model the populations.

For infants, the source of the raw data in the IOM (2005) database was from Butte et al. (2000), a DLW study conducted at the Children's Nutrition Research Center in Houston, TX. Butte et al. (2000) monitored energy expenditure in 76 healthy infants by the DLW method up to six times during the study, at 3, 6, 9, 12, 18, and 24 months of age, generating a total of 351 measurements that fell within the OEHHA-specified 0<2 year age group. Thus, many of the infants were tested more than once during the study period. Following each administration of DLW by mouth, urine samples were collected over 10 days and analyzed for the hydrogen and oxygen isotopes to calculate energy expenditure.

The percentage of breast-fed infants at ages 3, 6, 9, 12, 18, and 24 months were 100%, 80%, 58%, 38%, 15%, and 5%, respectively in the Butte et al. (2000) study. The racial distribution by maternal lineage was 55 white, 7 African American, 11 Hispanic, and 3 Asian infants. The NCHS growth reference (Hamill et al., 1979) was used to evaluate the adequacy of growth in these infants. The growth performance of these infants was comparable with that of other breast-fed and formula-fed infant populations in whom socioeconomic and environmental constraints would not be expected to limit growth. Relative to the NCHS reference and compared with other breast-fed and formula-fed study populations, the growth of the children was considered satisfactory by the researchers.

Although the study did not choose subjects representative of any particular population, the range of activities that individuals of this age engage in is not as variable as the range of activities engaged in by older children and adults. In addition, even though many of the infants were tested more than once during the study period, repeated measures on the same individuals can reduce the amount of intraindividual variability in the distribution of measurements because a better estimate of typical energy expenditure is captured. Considering the limitations, the study results were judged by OEHHA to be similar enough to a randomly sampled population to calculate distributional statistics for breathing rate.

An additional observation from Butte et al. (2000) was that total energy expenditure measurements differed by age and by feeding group, but not by sex, when adjusted for weight. As expected, PAL increased significantly with age from 1.2 at 3 months to 1.4 at 24 months.

Breathing rates determined by the DLW method for women in their third trimester of pregnancy are presented separately in Section 3.5.4.

To obtain the daily breathing rate distributions for all age groups shown in Table 3.20a-e, OEHHA fit the data to a lognormal distribution using Crystal Ball® and sampled 250,000 times using Latin-Hypercube. The lognormal distribution is commonly used in stochastic risk assessment and has been found to be a reasonable parametric model for a variety of exposure parameters, including breathing rate. Latin-Hypercube analysis in Crystal Ball® was also used to determine the best parametric model fit for the distribution of breathing rates. The Anderson-Darling statistic was used for the goodness-of-fit test because it gives greater weight to the tails than to the center of the distribution.

Tables 3.20a-e. Breathing Rate Distributions by Age Group (Males and Females Combined) Derived from IOM (2005) DLW Database Using Parameter Estimates of Lognormal and Best Fit Distributions

Table 3.20a. 0<2 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	281	281				
Skewness	-0.044	0.28	-0.001	0.44	-0.044	0.28
Kurtosis	2.10	2.59	3.00	3.35	2.10	2.59
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Beta	Beta
Sample Min	357	2228	-	-	-	-
Mean (SE)	567	5031	567	5031	567	5031
50%-ile	562	4967	567	4925	568	4943
80%-ile	657	6323	644	6232	655	6325
90%-ile	689	6889	685	6981	691	7042
95%-ile	713	7595	718	7638	714	7607
Sample Max	752	9210	-	-	-	-

Table 3.20b. 2<9 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	810	810				
Skewness	0.0759	0.4676	0.0796	0.4763	0.0796	0.0290
Kurtosis	2.93	3.62	3.00	3.40	3.00	3.50
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Log-normal	Student's T
Sample Min	240	5085	-	-	-	-
Mean (SE)	482	9708	482	9708	482	9711
50%-ile	479	9637	481	9521	481	9708
80%-ile	551	11,478	555	11,650	555	11,641
90%-ile	597	12,629	595	12,880	595	12,704
95%-ile	631	13,626	628	13,962	628	13,632
Sample Max	703	21,152	-	-	-	-

Table 3.20c. 2<16 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		**Moments and Percentiles, Lognormal Parametric Model**		**Moments and Percentiles, Best Fit Parametric Model**	
N	1227	1237				
Skewness	0.2729	0.8705	0.4613	1.12	0.2729	1.14
Kurtosis	2.45	3.70	3.38	5.32	2.45	5.43
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Beta	Max Ext.
Sample Min	168	5328	-	-	-	-
Mean (SE)	423	12,695	423	12,700	423	12,695
50%-ile	411	11,829	414	12,000	416	11,988
80%-ile	529	16,184	517	15,833	527	15,788
90%-ile	580	18,944	576	18,328	583	18,303
95%-ile	623	20,630	628	20,694	626	20,716
Sample Max	737	27,803	-	-	-	-

Table 3.20d. 16<30 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		Moments and Percentiles, Lognormal Parametric Model		Moments and Percentiles, Best Fit Parametric Model	
N	245	245				
Skewness	0.3471	0.4786	0.4008	0.6962	0.4008	0.6962
Kurtosis	3.03	3.11	3.28	3.88	3.28	3.88
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Log-normal	Log-normal
Sample Min	135	7246	-	-	-	-
Mean (SE)	222	16,458	222	16,464	222	16,464
50%-ile	220	16,148	219	16,053	219	16,053
80%-ile	256	19,468	259	19,395	259	19,395
90%-ile	282	21,954	282	21,410	282	21,410
95%-ile	308	23,295	302	23,231	302	23,231
Sample Max	387	26,670	-	-	-	-

Table 3.20e. 16-70 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Empirical Data		Moments and Percentiles, Lognormal Parametric Model		Moments and Percentiles, Best Fit Parametric Model	
N	842	846				
Skewness	0.4264	0.6323	0.4506	0.7346	0.4506	0.7346
Kurtosis	3.18	3.32	3.36	3.98	3.36	3.98
	L/kg-day	**L/day**	**L/kg-day**	**L/day**	**L/kg-day**	**L/day**
					Log-normal	Log-normal
Sample Min	95	7235	-	-	-	-
Mean (SE)	206	15,713	206	15,715	206	15,715
50%-ile	204	15,313	203	15,282	203	15,282
80%-ile	241	18,773	243	18,664	243	18,664
90%-ile	268	20,612	266	20,687	266	20,687
95%-ile	286	22,889	286	22,541	286	22,541
Sample Max	387	29,136	-	-	-	-

3.5.3 OEHHA Age Group Breathing Rate Distributions Derived From U.S. EPA (2009) MET Approach

In Tables 3.21a-e, non-normalized (L/day) and normalized (L/kg-day) breathing rates for the specific OEHHA age groups were derived for both children and adults from the data included in the U.S. EPA (2009) report and presented above. Values for males and females were combined by taking weighted averages for each age range provided, assuming that the numbers of males and females in the population are equal. Ages were combined by the same means to create the age ranges of toxicological interest to the “Hot Spots” program.

The breathing rates used in preparation of the U.S. EPA report were derived by selecting an activity pattern set from a compilation of daily activity pattern sets (CHAD) and assigning them to a person in NHANES of the same sex and age group, although the age groups are fairly narrow for the very young (i.e., 3-month or 1-year intervals), the older age groups consist of broad age categories (i.e., 3 to 5 year intervals). These broad age groups include periods, for example 3 to <6 years, when activity can vary greatly by year of age. In addition, NHANES calculates a “sampling weight” for each participant, which represents the number of individuals in the population with the same set of these characteristics. When an individual in CHAD is matched to an individual in NHANES only on sex and age group, the set of characteristics that belonged to the CHAD individual are ignored, which could result in significantly different weighting. Thus the derived breathing rates cannot be considered representative of the population.

For these reasons and other limitations of the EPA data, as stated in Section 3.3.3.3, OEHHA chose to fit a selected set of parametric distributions to the percentile data given by U.S. EPA, rather than attempting to use the raw data to determine the best fit parametric model. A gamma distribution was fit to each age group using Crystal Ball®, which is usually one of the better fitting distributions for the right-skewed distributions typical of intake variability. The gamma distribution is a three parameter distribution with fewer shape constraints than two parameter distributions such as a lognormal distribution.

Table 3.21a-e. Normalized and Non-Normalized Breathing Rate Distributions by Age Group (Males and Females Combined) Derived From U.S. EPA (2009) Breathing Rates Using a Gamma Parameter Estimate Distribution

Table 3.21a. 0<2 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Gamma Parametric Model	
N	1601	1601
	L/kg-day	**L/day**
Mean	1125	10,711
50%-ile	1104	10,489
75%-ile	1199	12,301
90%-ile	1302	14,104
95%-ile	1372	15,271

Table 3.21b. 2<9 Year Age Group Breathing Rate Distribution[a]

	Moments and Percentiles, Gamma Parametric Model	
N	4396	4396
	L/kg-day	**L/day**
Mean	597	12,758
50%-ile	591	12,518
75%-ile	662	13,911
90%-ile	732	15,375
95%-ile	776	16,176

[a] Breathing rate data for this age range were actually available for 2<11 years of age

Table 3.21c. 2<16 Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Gamma Parametric Model	
N	7657	7657
	L/kg-day	**L/day**
	449	13,365
50%-ile	440	13,106
75%-ile	496	14,694
90%-ile	555	16,426
95%-ile	595	17,609

Table 3.21d. 16<30 Year Age Group Breathing Rate Distribution[a]

	Moments and Percentiles, Gamma Parametric Model	
N	6111	6111
	L/kg-day	**L/day**
Mean	221	16,005
50%-ile	215	15,469
75%-ile	244	17,984
90%-ile	275	20,699
95%-ile	296	22,535

[a] Breathing rate data for this age range were actually available for 16<31 years of age

Table 3.21e. 16-70[a] Year Age Group Breathing Rate Distribution

	Moments and Percentiles, Gamma Parametric Model	
N	16,651	16,651
	L/kg-day	**L/day**
Mean	219	16,937
50%-ile	214	16,515
75%-ile	245	18,924
90%-ile	278	21,443
95%-ile	299	23,128

[a] Breathing rate data for this age range were given as 16<71 years of age

A limitation in calculating these breathing rates is that equal weighting by year of age was assumed when merging the U.S. EPA breathing rates into larger age groups used by OEHHA. However, this may not be a significant factor for the smaller age groups (i.e., 3rd trimester, 0<2, 2<9, 2<16, 16<30 yr old age groups), but could affect the breathing rate estimate for the 16-70 year olds. This is because a random sample of the population would find proportionally fewer adults in the 61 to 70 year age range, for example, compared to 21 to 30 year age range.

Another limitation is that merging the U.S. EPA age groups into the OEHHA age groupings does not yield the precise age range for 2<9 and 16 to <30 year olds. The actual age range in the US EPA data used to get the 16 to <30 year olds is 16 to <31, which we do not consider a significant deviation. However, the actual age range in the US EPA data used to get the 2 to <9 year olds is 2 to <11 years. The addition of 9 and 10 year olds would slightly reduce the normalized breathing rate in L/kg-day because younger children (i.e., 2<9 year olds) have higher normalized breathing rates than older children (i.e., 9-10 year olds). Alternatively, addition of 9 and 10 year olds to the 2<9 year age group would slightly increase the absolute breathing rate in L/day due to higher volumes of air breathed per day by 9 and 10 year olds compared to younger children.

3.5.4 OEHHA-Derived Third Trimester Breathing Rates

For third trimester exposure, OEHHA calculated breathing rates using the assumption that the dose to the fetus during the third trimester was the same as that to the mother. Both the CSFII and DLW data sets included data from pregnant women that could be used to calculate breathing rates (Table 3.22). The DLW data included a code for trimester of pregnancy, while the CSFII data did not. Thus, breathing rates by the CSFII method was estimated using data for women in all stages of pregnancy with no means for separation by stage of pregnancy. OEHHA believes this would not underestimate the third trimester breathing rates, since the CSFII breathing rate data tend to overestimate the breathing rate in the upper (e.g., 95^{th} percentile) and lower percentiles for the reasons cited in Section 3.4.3.2. Since breathing rate increases over the course of pregnancy, we felt that we could successfully combine these data with the DLW data and produce a reasonable set of point estimates for the third trimester.

In order to create a set of breathing rate data suitable for use in a stochastic risk assessment for third trimester pregnant women, we selected 1,000 observations from each set of data, normalized and non-normalized, using a Monte Carlo simulation in Crystal Ball®. Because the data sets from the two sources were similar in size, a relatively small set of simulated data was sufficient. We combined these data to create two sets of pooled data (see Section 3.2 above). We then fit a parametric distribution to each of the pooled samples, using Crystal Ball® and the Anderson-Darling goodness-of-fit test.

Table 3.22. Normalized and Non-Normalized Breathing Rate Distributions for Women in Their Third Trimester of Pregnancy: OEHHA-Derived Values from Doubly-Labeled Water (DLW) and Continuing Survey of Food Intake of Individuals (CSFII) Databases

	DLW L/kg BW-day	**CSFII L/kg BW-day**	**DLW L/day**	**CSFII L/day**
Distribution	Lognormal	Gamma	Lognormal	Gamma
Minimum	150	78	10,316	4,025
Maximum	348	491	23,932	29,041
Mean	220	232	15,610	14,830
Median	210	216	15,196	14,311
Std Dev	46	92	3,118	5,326
Skewness	1.19	0.5575	0.7744	0.4393
Kurtosis	4.04	2.57	3.57	3.02
Percentiles				
1%	150	84	10,316	4,025
5%	161	104	10,809	7,714
10%	174	127	11,846	8,201
25%	192	155	13,750	11,010
50%	210	216	15,196	14,311
75%	241	302	17,343	18,153
80%	246	323	17,832	19,114
90%	280	363	18,552	21,799
95%	322	392	22,763	24,349
99%	348	490	23,932	28,848

3.5.5 Summary of Long-Term Daily Breathing Rate Distributions

Table 3.23 presents a summary of the long-term daily mean and high end (i.e., 95^{th} percentile) breathing rates derived by OEHHA from different sets of energy expenditure data. The breathing rate distributions for women in their third trimester of pregnancy are presented separately in Table 3.22 above. The MET- (non-normalized only), CSFII- and DLW-derived breathing rates in Table 3.22 are based on the best fit parametric models for each age group, although little variation in the breathing rate was observed between models within each breathing rate method. Also included are data from TAV studies that estimated breathing rates in age groupings reasonably similar to that used by OEHHA.

As noted in Table 3.23, some of the age groupings for the MET-derived breathing rates, and all age groups in the TAV-derived breathing rates do not precisely reflect the age ranges used in the “Hot Spots” program. This was primarily due to methodological differences in data collection which did not allow individual breathing rates matched with the age of the individual. However, the differences in the age ranges were small enough in many cases to allow a rough comparison among the various breathing rate estimation methods, so they were included in the table.

TABLE 3.23. Summary of Breathing Rate by Study and Age Group

	0<2 yrs L/kg-day		2<9 yrs L/kg-day		2<16 yrs L/kg-day		16<30 yrs L/kg-day		16-70 yrs L/kg-day	
	mean	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**
MET[a]	1125	1372	597[b]	776[b]	449	595	221[c]	296[c]	219	299
CSFII[d]	752	1241	595	975	481	868	200	377	165	307
DLW[e]	567	713	482	628	423	626	222	302	206	286
TAV[f]										
Marty et al.	-	-	-	-	452[g]	580.5[g]	-	-	232[h]	381[h]
Allan et al.	-	-	-	-	-	-	-	-	201[e]	280[e]
	0<2 yrs L/day		**2<9 yrs L/day**		**2<16 yrs L/day**		**16<30 yrs L/day**		**16-70 yrs L/day**	
	mean	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**	**mean**	**95th**
MET[a]	10,711	15,271	12,758	16,176	13,365	17,609	16,005	22,535	16,937	23,128
CSFII[d]	7568	12,895	11,680	17,758	14,095	23,886	13,899	26,481	12,074	21,831
DLW[e]	5031	7595	9711	13,632	12,695	20,716	16,464	23,231	15,715	22,541
TAV[f]										
Marty et al.	-	-	-	-	8,100[g]	10,500[g]	-	-	14,600[h]	24,000[h]
Allan et al.	-	-	-	-	-	-	-	-	16,160[i]	22,480[i]

[a] U.S. EPA metabolic equivalent (MET) approach breathing rate point estimates shown were derived using the best fit parametric model from Tables 3.20a-e.
[b] All MET-derived breathing rates for the 2<9 yr age group actually represent 2<11 yr olds.
[c] All MET-derived breathing rates for the 16<30 yr age group actually represent 16<31 yr olds.
[d] CSFII food intake-derived breathing rate point estimates shown were derived using the best fit parametric model as presented in Tables 3.18a-e.
[e] Doubly-labeled water-derived (DLW) breathing rate point estimates shown were derived using the best fit parametric model as shown in Tables 3.19a-e.
[f] Time-activity-ventilation (TAV) breathing rate point estimates are from Table 3.3 (Marty et al. 2002) and Table 3.5 (Allan et al., 2008).
[g] The breathing rate point estimates from Table 3.3 actually represent an age range of about 3 to <12 yrs old. The non-normalized breathing rate point estimates in L/day is the equivalent for an 18 kg child.
[h] The breathing rate point estimates from Table 3.4 actually represent an age range of 12 to 70 years old. Non-normalized breathing rate point estimates in L/day are the equivalent for a 63 kg adult.
[i] Breathing rate point estimates were derived from Table 3.5 and represent an age range of 12 to 60+ years. The point estimates were calculated assuming equal weighting for each age group (12-19 yrs, 20-59 yrs, 60+ yrs) and combined. Breathing rates in Table 3.5 were available only in L/day, so the non-normalized point estimates were both divided by the mean body weight for the 16-70 age group (80.3 kg) to generate breathing rates in L/kg-day.

The DLW energy expenditure data likely result in daily breathing rates that are slightly lower in some cases than what would be expected in a random population sample, particularly for adults (Black et al., 1996). On the other hand, U.S. EPA (2008) observed that the upper percentile breathing rates for the MET and CSFII approaches are unusually high for long-term daily exposures. Based on the limits of sustainable daily breathing rates for adolescents and adults discussed in Section 3.4.4.3, the 95th percentile breathing rates in Table 3.22 appear to be above sustainable limits for some age groups. For example, the CSFII-generated upper percentile breathing rates are highest in the age groups containing older adolescents. The 16<30 year age group upper percentile breathing rate from the CSFII study is 377 L/kg-d. This breathing rate is above the sustainable breathing rate (based on PAL) of 283-353 L/kg-d for males 19-30 years of age shown in Table 3.16 (but is not above the sustainable breathing rates for the subgroup of males and females 14-18 yrs of age with a breathing rate of 332-513 L/kg-d).

A limitation of the estimated PALs for daily breathing rates determined in Tables 3.15 and 3.17 is that the participants used in the study may not reflect a random sample of the population. Nevertheless, the observed PAL of novice athletes training for endurance runs and soldiers during field training falls within this range of 2.0-2.5 (Westerterp, 1998; 2001). Thus, the breathing rates based on physical activity limits should be accurate for the general population, with the exception of professional endurance athletes in the most demanding sports (cross-country skiing and cycling) during training and competition.

With the advantages and disadvantages of the breathing rate datasets described in Section 3.2, OEHHA recommends using a daily breathing rate point estimates based on a mean of the DLW and CSFII approaches. The main benefit is the use of individual data from these two datasets, including individual body weights, which can be combined into one distribution. In order to create a set of breathing rate data suitable for use in a stochastic risk assessment of long-term daily average exposures, OEHHA combined data for each age range within the two sources of breathing rate data, CSFII and DLW. We selected an equal number of observations from each source for the five age ranges, normalized and non-normalized, using a Monte Carlo simulation in Crystal Ball® to create pooled data for each group. We then fit a parametric distribution to each of the pooled samples, using Crystal Ball® and the Anderson-Darling goodness-of-fit test.

For infants 0<2 yrs of age, OEHHA used the DLW data by Butte et al. (2000) for combining with CSFII study 0<2 yr data. This longitudinal study followed a group of about 40 infants collecting urine every 3 months after DLW administration from age 3 months to two years of age. The sample size was not considered large enough to use this data exclusively for determining the 0<2 yr breathing rates, so was combined with CSFII data of infants in the same age range.

3.6 8-Hour Breathing Rates

Specialized exposure scenarios for estimating cancer risk to offsite workers, neighborhood residents, and school children may involve evaluating exposure in the 8-12 hour range. Therefore, 8-hour breathing rates were estimated for exposed individuals engaged in activities that bracket the range of breathing rates including minimal inhalation exposure such as reading a book and desk work, and high breathing rates such as farm work or yard work, that can be reasonably sustained for an 8-hour period.

As part of the development of average daily breathing rates, U.S. EPA (2009) used existing data on minute ventilation rates (in ml/min or ml/kg-min) for a range of activities and assigned MET values depending on the intensity level of activity:

- Sedentary/Passive Activities: Activities with MET values no higher than 1.5
- Light Intensity Activities: Activities with MET values exceeding 1.5 to $\leq$3.0
- Moderate Intensity Activities: Activities with MET values exceeding 3.0 to $\leq$6.0
- High Intensity Activities: Activities with MET values exceeding 6.0

An additional ventilation rate distribution was developed for sleeping/napping only, although the sedentary/passive activity category (MET values ≤1.5) also includes sleeping and napping. Table 3.23 shows selected MET values for various workplace activities and activities in the home or neighborhood that were used to calculate daily breathing rates by U.S. EPA (2009).

Table 3.23. METS Distributions for Workplace and Home Activities

Activity Description	Mean	Median	SD	Min	Max
Workplace Activities					
Administrative office work	1.7	1.7	0.3	1.4	2.7
Sales work	2.9	2.7	1.0	1.2	5.6
Professional	2.9	2.7	1.0	1.2	5.6
Precision/production/craft/repair	3.3	3.3	0.4	2.5	4.5
Technicians	3.3	3.3	0.4	2.5	4.5
Private household work	3.6	3.5	0.8	2.5	6.0
Service	5.2	5.3	1.4	1.6	8.4
Machinists	5.3	5.3	0.7	4.0	6.5
Farming activities	7.5	7.0	3.0	3.6	17.0
Work breaks	1.8	1.8	0.4	1.0	2.5
Household/Neighborhood Activities					
Sleep or nap	0.9	0.9	0.1	0.8	1.1
Watch TV	1.0	1.0	-	1.0	1.0
General reading	1.3	1.3	0.2	1.0	1.6
Eat	1.8	1.8	0.1	1.5	2.0
Do homework	1.8	1.8	-	1.8	1.8
General personal needs and care	2.0	2.0	0.6	1.0	3.0
Indoor chores	3.4	3.0	1.4	2.0	5.0
Care of plants	3.5	3.5	0.9	2.0	5.0
Clean house	4.1	3.5	1.9	2.2	5.0
Home repairs	4.7	4.5	0.7	4.0	6.0
General household chores	4.7	4.6	1.3	1.5	8.0
Outdoor chores	5.0	5.0	1.0	2.0	7.0
Walk/bike/jog (not in transit) age 20	5.8	5.5	1.8	1.8	11.3
Walk/bike/jog (not in transit) age 30	5.7	5.7	1.2	2.1	9.3
Walk/bike/jog (not in transit) age 40	4.7	4.7	1.8	2.3	7.1

MET values and hr/day spent at these various activities were used by U.S. EPA (2009) to calculate selected minute ventilation rates shown in Table 3.24a-b.

Table 3.24a. Descriptive Statistics for Minute Ventilation Rates (L/min-kg) While Performing Activities Within the Specified Activity Category (US EPA, 2009)

Age Category (years)	Males				Females			
	Mean	50th	90th	95th	Mean	50th	90th	95th
	Sedentary & Passive Activities[a] (METS ≤ 1.5)							
Birth to <1	0.40	0.39	0.47	0.50	0.40	0.40	0.48	0.52
1	0.41	0.40	0.49	0.52	0.43	0.42	0.51	0.54
2	0.34	0.34	0.41	0.45	0.36	0.35	0.42	0.44
3 to <6	0.25	0.25	0.33	0.35	0.25	0.25	0.33	0.36
6 to <11	0.16	0.16	0.21	0.22	0.16	0.16	0.21	0.23
11 to <16	0.10	0.10	0.13	0.14	0.10	0.09	0.12	0.13
16 to <21	0.08	0.08	0.09	0.10	0.07	0.07	0.10	0.10
21 to <31	0.06	0.06	0.08	0.08	0.06	0.06	0.07	0.08
31 to <41	0.07	0.07	0.08	0.09	0.06	0.06	0.08	0.08
41 to <51	0.07	0.07	0.09	0.09	0.06	0.06	0.08	0.09
51 to <61	0.07	0.07	0.09	0.09	0.07	0.07	0.08	0.09
61 to <71	0.08	0.08	0.09	0.09	0.07	0.07	0.08	0.08
	Light Intensity Activities (1.5 < METS ≤ 3.0)							
Birth to <1	0.99	0.97	1.17	1.20	0.98	0.96	1.18	1.23
1	1.02	1.01	1.22	1.30	1.05	1.04	1.25	1.27
2	0.84	0.83	1.00	1.03	0.90	0.89	1.04	1.10
3 to <6	0.63	0.63	0.79	0.87	0.62	0.60	0.78	0.83
6 to <11	0.38	0.38	0.49	0.53	0.38	0.38	0.50	0.54
11 to <16	0.25	0.24	0.31	0.33	0.23	0.22	0.28	0.31
16 to <21	0.18	0.18	0.22	0.23	0.17	0.17	0.21	0.22
21 to <31	0.16	0.15	0.19	0.21	0.15	0.15	0.18	0.19
31 to <41	0.16	0.16	0.20	0.21	0.15	0.15	0.19	0.20
41 to <51	0.17	0.16	0.20	0.21	0.16	0.16	0.20	0.22
51 to <61	0.17	0.16	0.20	0.22	0.16	0.16	0.20	0.21
61 to <71	0.16	0.16	0.19	0.20	0.15	0.14	0.17	0.18
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)							
Birth to <1	1.80	1.78	2.18	2.28	1.87	1.85	2.25	2.40
1	1.88	1.82	2.33	2.53	1.90	1.87	2.24	2.37
2	1.55	1.54	1.84	2.02	1.60	1.58	1.92	2.02
3 to <6	1.17	1.12	1.56	1.68	1.14	1.11	1.45	1.56
6 to <11	0.74	0.71	0.96	1.04	0.72	0.71	0.94	1.01
11 to <16	0.49	0.47	0.64	0.68	0.44	0.43	0.55	0.61
16 to <21	0.39	0.38	0.49	0.52	0.36	0.35	0.46	0.49
21 to <31	0.36	0.34	0.47	0.51	0.33	0.32	0.42	0.45
31 to <41	0.36	0.34	0.47	0.52	0.32	0.30	0.41	0.46
41 to <51	0.37	0.35	0.47	0.52	0.33	0.32	0.44	0.49
51 to <61	0.38	0.37	0.48	0.55	0.34	0.33	0.44	0.49
61 to <71	0.34	0.34	0.40	0.42	0.29	0.28	0.35	0.37

[a] Sedentary and passive activities includes sleeping and napping

Table 3.24b. Descriptive Statistics for Minute Ventilation Rates (L/min) While Performing Activities Within the Specified Activity Category (US EPA, 2009)

Age Category (years)	Males				Females			
	Mean	50th	90th	95th	Mean	50th	90th	95th
	Sedentary & Passive Activities[a] (METS ≤ 1.5)							
Birth to <1	3.18	3.80	4.40	4.88	3.00	2.97	4.11	4.44
1	4.62	5.03	5.95	6.44	4.71	4.73	5.95	6.63
2	4.79	5.35	6.05	6.71	4.73	4.67	5.75	6.22
3 to <6	4.58	5.03	5.58	5.82	4.40	4.34	5.29	5.73
6 to <11	4.87	5.40	6.03	6.58	4.64	4.51	5.88	6.28
11 to <16	5.64	6.26	7.20	7.87	5.21	5.09	6.53	7.06
16 to <21	5.76	6.43	7.15	7.76	4.76	4.69	6.05	6.60
21 to <31	5.11	5.64	6.42	6.98	4.19	4.00	5.38	6.02
31 to <41	5.57	6.17	6.99	7.43	4.33	4.24	5.33	5.79
41 to <51	6.11	6.65	7.46	7.77	4.75	4.65	5.74	6.26
51 to <61	6.27	6.89	7.60	8.14	4.96	4.87	6.06	6.44
61 to <71	6.54	7.12	7.87	8.22	4.89	4.81	5.86	6.29
	Light Intensity Activities (1.5 < METS ≤ 3.0)							
Birth to <1	7.94	7.95	10.76	11.90	7.32	7.19	9.82	10.80
1	11.56	11.42	14.39	15.76	11.62	11.20	15.17	15.80
2	11.67	11.37	14.66	15.31	11.99	11.69	15.63	16.34
3 to <6	11.36	11.12	13.40	14.00	10.92	10.69	12.85	13.81
6 to <11	11.64	11.26	14.60	15.60	11.07	10.79	13.47	14.67
11 to <16	13.22	12.84	16.42	18.65	12.02	11.76	14.66	15.82
16 to <21	13.41	12.95	16.95	18.00	11.08	10.76	13.80	14.92
21 to <31	12.97	12.42	16.46	17.74	10.55	10.24	13.40	14.26
31 to <41	13.64	13.33	16.46	18.10	11.07	10.94	13.11	13.87
41 to <51	14.38	14.11	17.39	18.25	11.78	11.61	13.85	14.54
51 to <61	14.56	14.35	17.96	19.37	12.02	11.79	14.23	14.87
61 to <71	14.12	13.87	16.91	17.97	10.82	10.64	12.62	13.21
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)							
Birth to <1	14.49	14.35	20.08	22.50	13.98	13.53	19.41	22.30
1	21.35	20.62	26.94	28.90	20.98	20.14	27.09	29.25
2	21.54	20.82	26.87	29.68	21.34	21.45	27.61	28.76
3 to <6	21.03	20.55	25.60	27.06	20.01	19.76	23.83	25.89
6 to <11	22.28	21.64	27.59	29.50	21.00	20.39	26.06	28.08
11 to <16	26.40	25.41	33.77	36.93	23.55	23.04	28.42	31.41
16 to <21	29.02	27.97	38.15	42.14	23.22	22.39	30.28	31.98
21 to <31	29.19	27.92	38.79	43.11	22.93	21.94	30.02	32.84
31 to <41	30.30	29.09	39.60	43.48	22.70	21.95	28.94	31.10
41 to <51	31.58	30.44	40.28	44.97	24.49	23.94	30.79	33.58
51 to <61	32.71	31.40	41.66	45.77	25.24	24.30	31.87	35.02
61 to <71	29.76	29.22	36.93	39.98	21.42	20.86	25.72	27.32

[a] Sedentary and passive activities includes sleeping and napping

In order to obtain minute ventilation rates that represent age ranges used in risk assessment for the "Hot Spots" program, age groups in Tables 3.25a-b were weighted equally by year of age and combined by OEHHA. The male and female data were also merged assuming 50:50 ratio in the California population. Two of the age groups combined from the U.S. EPA MET data do not exactly reflect the age ranges used by OEHHA, but they were judged reasonably close enough to use (i.e., combined MET ages 2 to <11 yrs represents OEHHA's 2<9 yr age group; combined MET ages 16 to <31 yrs represents OEHHA's 16<30 yr age group).

Table 3.25a. Minute Ventilation Rates for OEHHA Age Groups in L/kg-min (Males and Females Combined)

	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	0.41	0.21	0.17	0.07	0.07
95th Percentile	0.52	0.29	0.24	0.09	0.09
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	1.01	0.52	0.42	0.16	0.16
95th Percentile	1.25	0.70	0.56	0.21	0.21
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	1.86	0.97	0.79	0.36	0.35
95th Percentile	2.40	1.33	1.09	0.49	0.48

Table 3.25b. Minute Ventilation Rates for OEHHA Age Groups in L/min (Males and Females Combined)

	0<2 years	2<9 years	2<16 years	16<30 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	3.88	4.67	4.94	4.85	5.27
95th Percentile	5.60	6.22	6.66	6.73	6.96
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	9.61	11.34	11.79	11.92	12.56
95th Percentile	13.57	14.80	15.67	16.15	16.24
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	17.70	21.25	22.58	26.08	26.95
95th Percentile	25.74	28.07	30.25	37.67	37.65

From these tables, the 8-hour breathing rates were calculated by OEHHA based on age groupings used in the Hot Spots program and are presented in Section 3.2. Eight-hour breathing rates based on high intensity activities (MET values >6.0) were not considered here because even at the 95th percentile, U.S. EPA (2009) showed that individuals spent only about 1 hour or less per day at this intensity. For moderate intensity activities, the 95th percentile was at or near 8 hours/day for some age groups. For women in their third trimester of pregnancy, we are recommending using 8-hour breathing rates based on moderate intensity activities.

3.7 Short-term (1-Hour) Ventilation Rates

SB-352 mandates school districts to conduct a risk assessment for school sites located within 100 meters of a freeway or busy roadway, and also mandates that the AB-2588 risk assessment guidance be used in the risk assessment. Assessing cancer risks due to exposure at a school site requires less than 24 hour breathing rates. OEHHA recommends breathing rates derived from the USEPA (2009) age-specific ventilation rates for these purposes.

The U.S. EPA ventilation rates were developed for various levels of activity and can be used to estimate inhalation cancer risk from short-term maximal emissions from facilities. Breathing rates for children at school can range from sedentary in the classroom to active on the playground or sports field. OEHHA assumes that in some cases, a day care facility will be present on the school site where children may be as young as 0<2 years of age. The age ranges that U.S. EPA (2009) presents are useful for estimating the impact of early-in-life exposure for school-age children. Classroom instructors (i.e., adults) are also considered under SB-352. If the soil ingestion or dermal pathways need to be assessed, OEHHA recommends the exposure variates presented elsewhere in this document. The public health protective approach is to assume that all daily dermal and soil ingestion exposure occurs at school.

As discussed in Section 3.6 above, U.S. EPA (2009) used existing data of ventilation rates (in ml/min or ml/kg-min) from a range of activities and assigned MET values depending on the intensity level of activity. Table 3.26 shows MET values various school-related activities collected from the CHAD database (U.S. EPA, 2009).

Table 3.26. METS Distributions for School-Related Activities

Activity Description	Mean	Median	SD	Min	Max
Passive sitting	1.5	1.5	0.2	1.2	1.8
Use of computers	1.6	1.6	0.2	1.2	2.0
Do homework	1.8	1.8	-	1.8	1.8
Use library	2.3	2.3	0.4	1.5	3.0
Attending day-care	2.3	2.3	0.4	1.5	3.0
Attending K-12 schools	2.1	2.1	0.4	1.4	2.8
Play indoors	2.8	2.8	0.1	2.5	3.0
Play outdoors	4.5	4.5	0.3	4.0	5.0
Recess and physical education	5.0	5.0	1.7	2.0	8.0

For OEHHA's purposes, the minute ventilation rates of males and females from Tables 3.24a-b were combined assuming a 50:50 proportional population distribution, and some age groups were combined assuming equal number of individuals in the population per year of age (Table 3.27a-b). For the SB-352, the child age groups were 0<2 years (infants), 2<6 years (preschool, kindergarten), 6<11 years (grade school), 11<16 (junior high and high school). From these minute ventilation rates, 1-hour ventilation rates are derived and presented in Section 3.2.

Table 3.27a. Minute Ventilation Rates for SB352 School Sites in L/kg-min (Males and Females Combined)

	0<2 years	2<6 years	6<11 years	11<16 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	0.41	0.28	0.16	0.10	0.07
95th Percentile	0.52	0.38	0.23	0.14	0.09
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	1.01	0.69	0.38	0.24	0.16
95th Percentile	1.25	0.90	0.54	0.32	0.21
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	1.86	1.26	0.73	0.47	0.35
95th Percentile	2.40	1.72	1.03	0.65	0.48
	High Intensity Activities (METS ≧ 6.0)				
Mean	-	2.27	1.37	0.92	0.64
95th Percentile	-	3.12	1.87	1.34	0.93

Table 3.25b. Minute Ventilation Rates for SB352 School Sites in L/min (Males and Females Combined)

	0<2 years	2<6 years	6<11 years	11<16 years	16-70 years
	Sedentary & Passive Activities (METS ≤ 1.5)				
Mean	3.88	4.56	4.76	5.43	5.27
95th Percentile	5.60	5.95	6.43	7.47	6.96
	Light Intensity Activities (1.5 < METS ≤ 3.0)				
Mean	9.61	11.31	11.36	12.62	12.56
95th Percentile	13.57	14.38	15.14	17.24	16.24
	Moderate Intensity Activities (3.0 < METS ≤ 6.0)				
Mean	17.70	20.75	21.64	24.98	26.95
95th Percentile	25.74	27.16	28.79	34.17	37.66
	High Intensity Activities (METS ≧ 6.0)				
Mean	-	37.34	41.51	48.69	50.10
95th Percentile	-	49.66	58.50	69.62	73.23

No high intensity minute ventilation rates are included in Tables 3.25a-b for infants age 0<2 yrs. The distributions generated by U.S. EPA (2009) for hrs/day spent at MET values ≥6.0 for infants (age 0<2 yrs) suggest that this level of activity for a 1-hr duration is unlikely for this age group.

SB-352 is also designed to protect adults working at the schools, including pregnant women. For women in their third trimester of pregnancy, OEHHA is recommending using ventilation rates of moderate intensity activities based on the same reasoning cited above in Section 3.6.

3.8 References

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COMMISSION ON COMMUNITY INVESTMENT AND INFRASTRUCTURE

RESOLUTION NO. 33-2015
Approved June 2, 2015

ADOPTING PROCEDURES FOR FILING OF APPEALS OF THE CERTIFICATION OF A FINAL ENVIRONMENTAL IMPACT REPORT FOR ENVIRONMENTAL LEADERSHIP DEVELOPMENT PROJECTS UNDER THE CALIFORNIA ENVIRONMENTAL QUALITY ACT

WHEREAS, Prior to its dissolution, the Redevelopment Agency of the City and County of San Francisco ("Redevelopment Agency") implemented numerous redevelopment plans approved by the Board of Supervisors and authorized under the California Community Redevelopment Law, Cal. Health & Safety Code §§ 33000 et seq. Under this state authority, the redevelopment plans established land use controls in project areas and did not generally rely on the San Francisco Planning Code or other local land use regulation, including Article 31 of the Administrative Code, unless a particular redevelopment plan required it; and

WHEREAS, State law dissolved the Redevelopment Agency on February 1, 2012, (Part 1.85 of the California Health and Safety Code (commencing with Section 34170)) (the "Redevelopment Dissolution Law"), and provided, among other things, that successor agencies assumed the rights and obligations of the former Redevelopment Agency (with the exception of certain affordable housing assets). In particular, state law requires successor agencies to fulfill enforceable obligations that the former redevelopment agencies had entered into prior to June 28, 2011 ("Enforceable Obligations"); and

WHEREAS, The Board of Supervisors, in its capacity as governing body of the Successor Agency, approved Ordinance No. 215-12 (Oct. 4, 2012) to implement Redevelopment Dissolution Law and established the Successor Agency Commission to which it delegated authority to exercise land use, development and design approval for "surviving redevelopment projects," subject to specified reserved authority for the Board of Supervisors acting as the governing body of the Successor Agency; and

WHEREAS, The Successor Agency to the Redevelopment Agency, commonly known as the Office of Community Investment and Infrastructure ("OCII"), is a legal entity separate from the City and County of San Francisco ("City"), has assumed the remaining rights and obligations of the former Redevelopment Agency, and has "succeed[ed] to the organizational status of the former redevelopment agency" with the authority "to complete any work related to an approved enforceable obligation," Cal. Health & Safety Code § 34173 (g); and

WHEREAS, OCII has the continuing authority and obligation: (1) to exercise land use controls required under Enforceable Obligations (including the Mission Bay North Owner Participation Agreement ("OPA"), the Mission Bay South OPA, the Disposition and Development Agreement ("DDA") for Hunters Point Shipyard ("HPS") Phase 1, the DDA for Candlestick Point-HPS Phase 2 DDA, the Transbay Implementation Agreement, and other OPAs and DDAs for projects that are not yet complete, and (2) to enforce the land use controls under redevelopment plans and related development controls where the City has not requested the transfer of land use functions to the City. These redevelopment plans include Zone 1 of the Transbay Redevelopment Plan, Zone 1 of the Bayview Hunters Point Redevelopment Plan, the HPS Redevelopment Plan, the Mission Bay North and South Redevelopment Plans, the Rincon Point-South Beach Redevelopment Plan, and the Bayview Industrial Triangle Redevelopment Plan; and

WHEREAS, The Redevelopment Dissolution Law provides, among other things, that successor agencies may take actions in compliance with enforceable obligations and for the purpose of winding down the redevelopment agency. Cal. Health & Safety Code § 34177.3; and

WHEREAS, The OCII has a continuing need to review and approve development projects, including design and environmental review, as part of the wind down of redevelopment agencies; and

WHEREAS, OCII is currently reviewing a multi-purpose event center and mixed used development that the Golden State Warriors, through its affiliate GSW Arena LLC, have proposed under the Mission Bay South Redevelopment Plan and the Mission Bay South OPA and that Governor Jerry Brown has certified, on April 30, 2015, as an "environmental leadership development project" ("Leadership Project") under the Jobs and Economic Improvement Through Environmental Leadership Act of 2011 ("AB 900"). Cal. Public Resources Code §§ 21178 et seq., and

WHEREAS, Under AB 900, OCII as the lead agency under the California Environmental Quality Act, must certify finally an environmental impact report for, and approve, a Leadership Project prior to January 1, 2016; and

WHEREAS, To ensure adequate public participation and review of environmental impact reports for Leadership Projects ("Leadership Project EIRs"), OCII proposes special procedures for the filing of appeals associated with Leadership Project EIRs, including filing an appeal with OCII within ten days of the Final EIR certification and requiring OCII to review the appeal for sufficiency and completeness and to transmit the appeal to the Clerk of the Board of Supervisors; and

WHEREAS, OCII proposes that the Board of Supervisors, acting in its capacity as the governing body for the Successor Agency, follow standards and procedures for scheduling and conducting a public hearing that it has previously established for similar appeals of CEQA decisions by the Planning Commission or other City agencies. NOW THEREFORE BE IT,

RESOLVED, that the Commission on Community Investment and Infrastructure hereby adopts the Procedures for Appeal of EIR Certifications of Environmental Leadership Development Projects approved by the Office of Community Investment and Infrastructure, attached as Exhibit A to this Resolution.

I hereby certify that the foregoing resolution was adopted by the Commission at its meeting of June 2, 2015.

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Commission Secretary

Procedures for Appeal of EIR Certifications of Environmental Leadership Development Projects approved by the Office of Community Investment and Infrastructure

This policy establishes the procedures under which the Successor Agency to the Redevelopment Agency of the City and County of San Francisco, acting through the Office of Community Investment and Infrastructure, or its Commission (collectively referred to as "OCII"), will provide that OCII's certification of an environmental impact report for a qualifying Environmental Leadership Development Project under the Jobs and Economic Improvement Through Environmental Leadership Act of 2011, Cal. Public Resources Code §§ 21178 et seq. ("Environmental Leadership EIR" or "EIR") may be appealed to the Board of Supervisors (the "Board"). The appeal procedures are as follows:

(1) Only persons or entities that submit comments on a project either in writing during the public review period of an Environmental Leadership EIR, or orally or in writing at or before the close of OCII's public hearing, may appeal OCII's EIR certification to the Board.

(2) The appellant shall submit a letter of appeal to the OCII Executive Director or his or her designee (collectively referred to as "OCII Executive Director") within 10 calendar days of OCII's Environmental Leadership EIR certification. If the 10th day is a weekend or holiday, the appellant must submit the letter of appeal no later than the next business day.

(3) A letter of appeal shall be timely filed only if it is received by the OCII Executive Director no later than 5:00 PM on the day the letter of appeal must be submitted under paragraph (2).

(4) The letter of appeal must state the specific grounds for appeal of OCII's Environmental Leadership EIR certification and include references to the written or oral comments that were timely submitted to OCII raising the issues identified in the appeal, and any other written materials in support of the appeal. The appeal may be based only on specific CEQA grounds alleged by any persons or entities before OCII makes its decision on the project. For purposes of these procedures, "project" has the meaning set forth in CEQA Guidelines, Title 14 CCR, Division 6, Chapter 3, Section 15378 and "approval" has the meaning set forth in Section 15352.

(5) The appellant must sign the letter of appeal, or may have an agent sign and file an appeal on the appellant's behalf.

(6) Upon receiving an appeal, the OCII Executive Director must determine whether the appeal has been filed in a timely manner and otherwise complies with the requirements of these procedures. Within five business days of the filing of the appeal, the OCII Executive Director must mail notice to the appellant of OCII's acceptance or rejection of the appeal. If the appeal is accepted, at the same time, the OCII Executive Director must advise the Clerk of the Board of the notice of OCII's acceptance of the appeal, request that the Clerk set the appeal for a public hearing before the Board, and provide a copy of the letter of appeal and a list of individuals and organizations that have requested notices relating to the project. A decision by the OCII Executive Director rejecting an appeal is final and may not be appealed.

No further action is required by the OCII Executive Director or OCII for a letter of appeal that has been rejected.

(7) Once the Clerk of the Board has scheduled the appeal for public hearing, the OCII Executive Director must promptly, but no later than 11 calendar days before the scheduled hearing, transmit copies of the environmental review document to the Clerk of the Board and make the administrative record available to the Board. Also, the OCII Executive Director must otherwise assist the Clerk of the Board in accordance with any procedures established by the Clerk of the Board for such appeals.

(8) In adopting these procedures, OCII recognizes that the Board, in considering any appeal of a OCII's Environmental Leadership EIR certification, may follow the standards and procedures for a hearing that the Board has established for similar appeals of CEQA decisions by the Planning Commission or other City agencies.

(9) If the Board reverses OCII's Environmental Leadership EIR certification, OCII must take further action under CEQA in compliance with the Board's appeal findings. Any further appeal from a subsequent CEQA decision by OCII after such remand shall be limited to the adequacy of changes made by OCII in response to the Board's findings relating to the initial appeal.

(10) If the Board affirms OCII's Environmental Leadership EIR certification, the date of the final EIR shall be the date upon which OCII first certified the EIR and any actions approving the project made prior to the appeal decision shall be deemed valid.

(11) The date the project shall be considered finally approved must occur no earlier than (1) the expiration date of the appeal period if no appeal is filed, (2) the date the OCII Executive Director rejects the appeal, or (3) the date the Board denies the appeal.

(12) After OCII has decided to approve the project and the project is considered finally approved as provided for Paragraph 11, in accordance with CEQA procedures, and upon the payment of required fees by the project sponsor, the OCII Executive Director shall file a notice of determination with the County Clerk for an environmental impact report. If required by CEQA, the notice of determination shall also be filed with the California Office of Planning and Research. When the OCII Executive Director files a notice of determination with the county clerk or the California Office of Planning and Research or both, OCII also shall post a copy of the notice of determination in the offices of OCII and on OCII's website, and mail a copy of the notice of determination to organizations and individuals who previously have requested such notice in writing.

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